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PREFACE

The ‘International Symposium CIB-W096 2009 Taiwan, Future Trends in Architectural Management’ came to reality after the announcement posted by the CIB on Dec. 12, 2008. The gradual emergence of this conference went on for three years through friendly and cordial communication and coordination started from the Adaptables Conference in Eindhoven 2006.

This symposium aims to discover applications of architectural management in the past, to discuss the present worldwide condition of architectural management as well as to anticipate and to plan for the future role of architectural management. The symposium serves as a meeting ground of experts from around the world and will be an opportunity for them to share their experiences, problems and the solutions they have responded with, especially the solutions utilizing state-of-the-art technology.

Well supported by socio-economic development, and founded by the advancement of progressive technologies including the application of new techniques, construction methods, and materials, the production of architecture has transformed itself into a holistic qualitative experience that encompasses our daily living and fulfillment of accumulated lifelong experiences. Architectural management, in the city scale, could promote and create a healthy development for urban environment as well as reinforce the governance of issues concerning public safety.

Considering the cooperative as well as competitive models of current globalized economic development, the integration and international cooperation among regional economic organizations is forming recognizable trend. In order to precisely grasp the influence posed by architecture as well as various weather conditions, the local cultural and social conditions have to be taken into consideration in space planning and building design to reflect the current technological development and new management techniques.

Issues regarding environmental control play significant roles in the policy making that concern the management of environmental sustainability. Therefore, the technical endeavors applied in the making of policy are valuable and require more open discourses to sustain better integrity. It is our view that issues concerning ‘Applications of architectural environment control and management technologies’ play an important role in the current local situation. Vice versa, the proficiency of policy counts on the availability of the relevant applications and management of technologies. It is our intention that this extended theme could add to the support of architectural management in a broader sense.

Chun-Ta Tzeng
Stephen Emmitt
Matthijs Prins

Taiwan, November 2009.

CONTENT

KEYNOTE ABSTRACT

Management in Architecture: insights and developments

Professor Stephen Emmitt
Loughborough University, UK

Abstract

The term architectural management was first used in the UK in the 1960s to describe the synergistic relationship between the professional management of the architect's office and its project portfolio. From the 1960s until the start of the 1990s only a very small amount of work was published on architectural management and guidance for practitioners was in short supply. A conference on architectural management in 1992 led to the formation of CIBW096 in 1993, and a core of dedicated researchers and practitioners started to meet on a regular basis, discuss pertinent issues and publish in the field. Collectively this body of work has started to define the architectural management domain, as witnessed in the first book by CIBW096 members *Architectural Management: international research and practice*. Parallel to this has been the development of (construction) design management by contractors, with a rapid growth in the development and application of the design management role as contractors take greater responsibility for design. With greater appreciation of the value of design by project stakeholders has come the need to better manage design activities; the application of creative management to architecture. This keynote presentation looks at the origins of architectural management, provides an overview of the practical application of management by architects, and concludes with some thoughts on current trends and future developments for practice, research and education. Emphasis is on the competitive advantage to be gained via architectural management.

Keywords

Architects, Architectural Management, Competitive advantage, Construction design management, Creative management.

Biography

Stephen Emmitt is an architect, experienced design manager and professor of architectural technology at Loughborough University, UK. Stephen is joint coordinator of the CIB W096 Architectural Management and has been a member of CIBW096 since 1994. He has published widely in field since 1994. Books include the seminal work *Architectural Management in Practice: a competitive approach* (Longman, 1999) and *Design Management for Architects*, (Blackwell, 2007). Edited books include *Aspects of Design Management* (Earthscan, 2007), *Design Management for Sustainability* (Earthscan 2009) and the recent work by members of CIBW096 *Architectural Management: international research and practice* (Wiley-Blackwell, 2009)

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Architectural Design Management：
Essence of the domain and future challenges

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INTRODUCTION

Architectural Management emerged as a domain in the early nineties of the previous century as a small group of academics, professionals and representatives from professional bodies took the initiative to establish the CIB working commission W096 Architectural Management.

Although Architectural design and it's management always had been in the focus of interest also other phases of construction and building processes, in their dependence to design, had been within the interest of the commission.
Management of projects normally has a dual focus: creating a good process to deliver a wished result. In case of the management of design processes this becomes rather complicated. During its history up till now a great deal of the focus of architectural design management was on the facilitating of value creation. 'Value through Design' and how to facilitate value creation was and is one of the main interests of the domain.

This presentation consists of two parts. The first part addresses the nature of architecture value, how the different parties involved see it, and how its creation can be facilitated by the implementation of management.
In the second part the attention is shifted towards future developments and challenges.

ON THE VALUE OF ARCHITECTURAL DESIGN AND ITS MANAGEMENT

Architects often are reluctant to managers and management specialists coming into the construction process, which is also the case when architectural design managers are concerned. This much has to do with the different professional paradigms of architectural designers and managers. As for instance professional managers often consider quality in terms of conformance to requirements, or fitness for purpose and mainly are concentrating on measurable aspects, for architects quality or value as is the most used word, embraces a whole world of intangible, rather personal, subjective and intrinsic aspects, often not measurable and difficult to communicate about.

Seen from a regular managerial paradigm which is on planning, measurement, assuring and controlling, basically founded in the conviction that reality can be predicted, modeled and understood, architecture with intrinsic and sometimes idealistic values (even to transform a whole society) seems a total different world. This is even more the case in today's post-modern, super modern or de-constructivists movements.

Although management and architectural design have different paradigms in case of design management these two domains each with their different convictions and languages ought to need a certain base on how to communicate about wished end results. Besides the more regular technical, financial and functional aspects there must be a kind of mutual understanding on the value of design, and how design value arises out of a rather complex set of interrelated factors.

Necessary is a framework of architectural value, which can be shared, which is multifaceted in its interpretation, but has enough robust consistency to address the paradigmatic pluralism as well as giving ground to an elementary shared language between the parties involved. An attempt for such a model will be presented.

Value thinking is not representative or exclusive only to architects and clients, but for all those involved in building design and construction. It might be assumed given the multifaceted and pluralist nature of value, added architectural value foremost arises out of synergy on the value concepts of all participants. This rather than on the degree and amount of which constituent elements of architectural value are made explicit, quantified, measurable and manageable. Whatever the case, it is essential that architects and other stakeholders attempt to address value and values as part of a managerial ethos to architecture.

FUTURE CHALLENGES

Besides the more fundamental questions on the paradigmatic foundations of architectural design management and belonging to that value creation, there are a series of recent developments, which further will be dominant for the growth of the domain and future research which will be addressed shortly below.

In several parts of the world there is a sharp rise in large and complex public projects in which whole area's and a series of buildings have to be designed. To execute these types of complex projects often high profile design teams are compiled in which several architectural firms are collaborating. Managing these teams asks for models to enhance creative teamwork, collaboration and knowledge sharing. For managing these complex projects the concept of 'managing by designing' is developed which shortly will be introduced, but needs to be developed further.

Another important shift in professional practice is the rise of so called integrated procurement like PFI contracts. The traditional borders between tasks and occupational groups become blurred since architects, consulting firms, contractors, subcontractors, and suppliers are all standing on the supply side in the building process while the client on the demand side. Such configuration of the design team puts the architect in a very different position that influences not only his role but also his responsibilities and tasks and communication with the client, the users, the team and other stakeholders. A new challenge for design management emerges in case of positioning an architect in partnering with the contractor or with the client.

Industrialization, mass customization, and open building manufacturing are asking for designs which are based on as well a thorough knowledge of construction and production as well as clear visions of future use and balanced calculations of whole life costing and sustainability. Design management might help architects to take into account the compatibility of dimensions, components, and technology platforms in order to effectively, efficiently and economically engineer, manufacture and realise sustainable design.

Connected to the above the construction sector as well as clients more and more are asking for Integrated Design and Delivery Solutions requiring collaborative work processes and enhanced skills, with integrated data, information, and knowledge management (BIM) to minimize structural and process inefficiencies and to enhance the value delivered during design, build, and operation, and across projects. This development really might change the way we work in construction and might ask for a thorough re-thought on processes, collaboration and management in design and construction

Taipei Beautiful: How does government policy affect architectural management?

Yeng-Horng Perng*[1]
Yuh-Chyurn Ding*[2]
Lung-Jin Wang*[3]

Abstract

This article is a case study of the public policy and action plans for the architectural management of Taipei City. To prepare the city for the 2009 Deaflympics and the 2010 International Flora Expo as well as to improve long-lasting competitiveness, the Taipei city government (TCG) set up an urban regeneration strategy with eight action plans in 2008 to enrich the cityscape using sustainable approaches. These eight action plans are summarized as follows.

First, incentives are provided to encourage new building designs to reduce the coverage percentage of each building site and allowing more open space for plantings and rain water penetration. Second, assistance is offered to the owners of obsolescent buildings in demolishing the existing structures and providing planting plans and advice for the sites. Third, subsidies are made available for cleaning or refurbishing of building facades to improve streetscapes, also, to upgrade weather resistance and energy preserving capability of the existing building envelopes. Fourth, subsidies are also granted for commercial signboard redesign and the installation of energy saving LED lighting systems. Fifth, budgets are allocated for removing solid walls from major public schools to create open campuses and green fences. Sixth, planting assistance is offered for idle sites and spaces within certain focal areas. Seventh, lighting systems are supplied for historical buildings and major attractions. Eighth, painting for public buildings has been untaken to beautify building façades and reduce heat gain by the building envelopes.

The aforementioned public policy and action plans are expected to prevent more than 200,000 tons carbon dioxide emission, to provide versatile and attractive cityscapes, to serve as boosters for many economic activities and many other intangible effects. Lessons learned from these attempts to manage the city should provide insight for other managers.

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Value and challenge of virtual collaboration and communication in architectural design

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The field of Architectural Management starts somewhere in the immaterial world of initiating, planning and design of buildings and ends somewhere in the material world when the artifact designed is realized. Start and end mainly depend on organizational issues and governance of the project owners or representatives. Collaboration and communication of architectural firms, managing architects and architectural managers varies in projects due to configuration of the, mostly multidisciplinary, design teams and governance. Today the world of architectural design, being a vital part of building and construction projects, is still dominated by paper for communicating design on the project level. Contracts, sketches and drawings and various design documents, approvals on paper are valued higher than electronic ones. Only a few project managers, architects and advisers trust electronic information as they trust their electronic bank account. Electronic information might be good enough for the work floor to generate design documents but usually is not good enough to approve design. Due to that electronic and paper copies exist of the same subject however differ in status and version, of which at least one is outdated. Because of the continuously growing flow of design changes during designing the overview on the actual state of the design increasingly tends to be inadequate and ambiguous. Misunderstanding, inefficiency and design failures are the result.
Due to trust on old systems, fear for the copying vital knowledge from the databases and mistrust for external system managers, it is not easy to switch fully to electronic information. Nevertheless the proponents of Building Information Models (BIM) believe the role of the architect and his team will change drastically in the near future,

Architectural design usually is communicated in multidisciplinary, geographically dispersed teams. Today's new collaboration technologies, specifically for sharing of documents in projects and for BIM challenge such teams from the early start of design. Such collaborative systems support the sharing of integrated design information, under condition that the same standards and codes are used. Design teams today face the challenge of not only delivering the artifact as designed within time and budget, but also to maintain it's functioning and performance over the full period of use. This sets a quest for change from paper based communication to new collaborative communication technologies that are promising but still have to prove their usefulness and effectiveness. This might be partly a matter of learning and training new skills but in order to be effective it needs another mindset for collaboration and communication and the re-design of communication flows and management structures. Due to implementation of BIM, design organizations need to become networked organizations based on electronic design team communication in order to be successful.

Architects should realize that in this era sharing information gives more benefits than hiding it, and that information in well organized project websites is much more secure than strategic secret information stored in PCs' in well locked offices but casually connected to the internet.
So there are a few important challenges to take for architectural firms, managing architects and architectural managers to be successful tomorrow: communication processes need to be changed radically to get a vital role in the collaboration and to take over from paper to electronic! The real value is not in having up-to-date electronic documents, but in being able to handle more complex projects collaboratively and in being more responsive to user demands.

KEYNOTE ABSTRACT

Management in Architecture: insights and developments

Architectural Design Management:Essence of the domain and future challenges

Taipei Beautiful: How does government policy affect architectural management?

Value and challenge of virtual collaboration and communication in architectural design

SECTION 1

SUSTAINABLE ARCHITECTURAL DESIGN MANAGEMENT AND PUBLIC POLICY

Performing Building Projects, Constructing Planned Fiasco: An Appraisal of the Autopoietic Spatial Configuration of City Plans, Design Codes, and Project Managements at A High-Profiled District in Kaohsiung

Horng-Chang Hsieh[1]

ABSTRACT

Planned spatial visions always differ from the developed ones. Conformance and performance are argued to be two distinct ways of evaluating implementations in spatial planning. The former denotes implementing development projects exactly conforms to the officially planned scheme whilst the latter connotes managing building projects to meet the operational standards set by the developers to achieve better efficiency and more profit. And the developers are usually the ones to be blamed for creating such fiasco by rent speculation.
Using ethnographic data gathered from the field of Nei-Wei Pi -- the first designated urban design area and special cultural district in Kaohsiung, we argue that the performative explanation of developers' project management styles is much better for us to undestand; as the builders adjust their organization of spatial arragements to meet their market expectation, the spatial configuration of the building context changes. Which, results, collectively, to constitute a new vision that contradicts the planned one. The causes of this performative development are briefly delineated by the spatial autopoiesis argument in this paper; and we argue that unless we have more understanding of the builders' performances in cultivating markets, all *good* city design discourses with different templates are deemed to be futile.

KEYWORDS

Building project management; Urban design; Performative market; Autopoietic spatial configuration; Kaohsiung

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1. Introduction

The discrepancy between planned visions and the developed spatial realities has been a recurring common theme in the debates of *a* good urban design framework among the communities of practice in urban planning (Barnett, 1986; Blau, La Gory, and Pipkins eds., 1983; Hall, 1982; Kolson, 2001; Von Eckardt, 1978). Upon this matter, the powerbrokers, the incapable planners and the speculating developers are usually the sure culprits for blames. Not much has been discussed about on the nature of managing a building project in planning discourses. That is why we start this investigation.

Willem K. Korthals Altes (2006) , in his examination of the Dutch VINEX policy, shows that while the spatial contours of VINEX conforming well to the urban plan it nonetheless performs poorly to produce “planned stagnation.” Because most house-builders are driven to places where they can make profits so that the planned vision is never realized by them. This incident reopens the debate on conformance *vs*. performance in planning performance measure. And, it highlights the re-examination of policy flexibility and the market development in terms of cost/benefit in implementation. This paper takes its current form by this inspiration.

In line with this argument, we beg a close scrutiny of the building project management, especially, the developer’s *devices* in *performing markets* (*cf*. Callon, Milo, and Muniesa eds., 2007), to understand how the planned area is appreciated by the builders to develop collectively. We term this way of understanding the developer’s project management *performative approach*.

In what follows, the paper is organized in four parts: first, we delineate the *performative approach* in brief for our systemic analysis; second, we layout the context of the officially planned vision for the development of Nei-Wei Pi, Kaohsiung to describe the field of our ethnographic investigation; third, we analyze the interviewed data of our targeted developers and contrast their project strategies with the realized spatial development; and last, we offer a conclusion from an autopoietic point of view and a tentative policy suggestion.

2. Performative approach to study building projects: from building the markets to marketing the buildings

Performative approach gained its popularity at the turn of the century, through various unyielding investigations in social studies of technology and science (STS), especially on economics (e.g., Barry and Slater eds., 2005; Callon ed., 1998; Callon and Musiesa, 2005; Callon, Milo and Muniesa eds., 2007; MacKenzie, Muniesa and Siu eds., 2007). The concept *performativity* was initially related to speech act theory, to the pragmatics of language and the works of British philosopher of language John Langshaw Austin (1911-1960). It accounts for situations where a proposition may constitute or instantiate the object to which it is meant to refer. It is later proposed by Michel Callon (1998) in his studies on markets and economics that “economics, in the broad sense of the term, performs, shapes and formats the economy, rather than observing how it functions.” (p. 2).

To make the rich literature systematic to fit our analysis, we summarize it in the following three sections.

2.1 The architecture of markets

Theoretically, a "new" real estate market never pre-exits; it starts building from *void*. However, the goods and services that render *a* market vary constantly, so do the prices. In the processes of making a new house unit to be sold at the market, some enrolments and counter-enrolments of the constituents of a house, materially and discursively, occur consecutively (Callon and Law, 1982). In the developers' lingos, initially, a piece of land with its surroundings is viewed as a *location*, then, a *building site*, and finally, a *project*. Each "translation" of the term attaches more meanings to that piece of land to make sense for the classification and articulation of a unique *marketable product* (Breiger, 2005). It is a common practice among developers; but, the incremental nature of this classification is seldom mentioned in the planning and design literature, and the real estate market studies as well.

The land and its ambience provide the context for builders to operate, to manufacture housing products for real estate market, and to formulate project management strategies to draw an *operational closure* (*cf*. Burt, 2005; 1989; Luhmann, 1990). Each building project can be deemed as a micro-system operating in a building firm -- as its external environment; and the company is operating among rival companies striving for land and financial resources to make profit for survival. Within this organizational ecology, projects are performing against other projects and firms are competing against other firms. With or without ostensible coordination, some real estate markets get stabilized and emerge; and, the partitioned designs and plans transform the built environments that become the spatial configuration of cities. To borrow the term from German sociologist Niklas Luhmann, we call this phenomenon *spatial autopoiesis* (Koch, 2005); and the self-organization of this spatial manifold gets its start from performing a single building project.

Initially, to perform a building project, a distributed cognition of land market is a must. That makes the official spatial regulation a necessary but not sufficient reference. Builders will take notice of this regulation as what they *cannot do* instead of what they *have to do*. However, even if the land is purchased, the plan and design of this project will not immediately partake in the project management. Because of the precarious nature of the market and financial risks incurred to the sunken fund for land, some insurance measures must be secured first (Mayall, 2008). That brings in analyses -- analyses for the classified products and their corresponding values. The values are not just numeric figures; they not only specify the market-level prices and the potential consumers, but also the corporation's profit margins. They play a sophisticated role in the processes of what Franck Cochoy (2008) terms "calculation, *qualculation*, and *calqulation*" in equipping the developers' cognition of *the market* to make up of what Callon, Méadel & Rabeharisoa (2005) call *the economy of qualities*.

The corporation's profit margins can be roughly secured by two types of contradictory organizational behaviours: risk-embracing profit motives and risk-averse precautionary instincts, they both play important parts in building project management prior to marketing. While the spatial regulations, such as land-use zoning, urban design ordinance, and building codes form a collect of external constraints on building project decisions, the in-flows of financial and material resources for the developer form an internal one. The developer organizations, as posited by Power (2007), run their businesses by efficient and effective internal self-controls that must incorporate risk-based science, law, and managerial techniques. And, we shall argue that, in performing their decisions to sustain the corporation's survival, the materialization of their building projects will not necessarily conforms to the official design of urban plans. It is a game for the survival of the fittest.

2.2 Partitioning the projected market

By classifying commodities with their qualities, the developers do not just elaborate on their prices-to-sell, but also their targeted consumers' preferences and prices-to-pay. They segregate products to create differentiated markets, then articulate prices to create hierarchical markets. A euphemism for this project management strategy can be termed "lifestyle marketing"; nevertheless, a market only exists when a transaction is done. And, as Beunza, Hardie and MacKenzie (2006) have observed, "a price is a social thing". Therefore, the profiles of their potential consumers must be constructed beforehand.

Comparing with commercial real estates, residential housing market is relatively stabilized; partly because of the lesser degree of house-buyers' job-mobility and partly due to the nature of embedded market networks. The local housebuilding firm boundaries are fluid and subcontracting is the norm. Hence cities can be seen as the industrial districts of housebuilding (Buzzelli and Harris, 2006). This relatively confined basis provides abundant opportunities for the homebuilders to operate and innovate. To the extent that the majority of developers in Taiwan are homebuilders of small and medium size, and their business decisions perform and shape the spatial configurations of every Taiwanese city.

In the business of selling homes, profile marketing is a convenient way to commoditize housing types by classifying household types, and that in turn standardizes the building types. However, because the differential rent created by land-use zoning regulation determines the initial capital for building construction; therefore, the marketing strategy of standardized housing commodities usually comes with prostheses – the location and/or the developer's name. Housing commodities thus become not just selections of lifestyle but also status symbols. In operation, the homebuilders will take the initial capital for land plus the symbolic value of the house to tailor their programs for projects in order to market the buildings. This managerial process involves a variety of calculations and modifications for risk-taking and uncertainty-controlling. Some of the manoeuvres are very meticulous before the houses get to test the market. But, some traces of path dependence and convention can still be found; and, "formula" and rules of thumb are usually detectable. These can all be termed *market devices* for the developers to perform, as we will delineate in the analysis below.

2.3 Re-configuring the market and changing project management styles

Having done with the partitioning of a projected market, the builders will seek to know the estimated profits. But, this is not an easy calculation. Most established building firms do not take a building project as a one-shot deal; they also have watchful concerns with the continuing operation of the firm in the future. Thus, they scrutinize the housing stock at their projected markets, monitor the business operations of rival companies, and, most of all, they do vigilant inventory checks to their operational cash-flows. To avoid unexpected abruption in their managerial styles, some sort of "shockproof mechanisms" must be established for self-reference (*cf*. Luhmann, 1990). In good years, the building firms will follow the convention, doing business as usual. In bad years, they evoke the "mechanisms" for self-referential and make adaptive strategies accordingly – some can even be termed "innovations".

In our observation, those "mechanisms" are all land-related. Lands are used as company assets to secure stock market value to get public investments; lands are also used as collaterals to creditors for borrowing construction finance. In addition, lands can also be sold as commodities in exchange of emergency money and/or as the jettison of property taxes. But, the most radical one is to use prices of the lands-expected-to-purchase as the benchmark for the design and management of current project. In this innovative case, lands become what Zwick and Dholakia (2006) call *epistemic consumption objects*. The changes in a developer firm's dealing with lands affect the performance of a building project; that, in turn, re-configures the projected market.

3. The Field of investigation: special cultural district of Nei-Wei Pi, Kaohsiung

3.1 A very short history of Nei-Wei Pi

Nei-Wei Pi (Figure 1), a place at the west bank of Love River, was originally a backwater area for irrigation functioning only. Since the first national economic plan of 1953, it was designated as a light-industrial district and turned into plywood production area using the river routing to import lumbers from Southeast Asia. In late 1970s, because the ASEAN countries signed a treaty to embargo exports of lumber abroad, most of the plywood manufacturers moved to the countries of origin and plant foreclosure and abandonment followed in. The place was then turned into a park-reserve for reassignment by the municipality. On 1992, in response to local artists' campaign for the establishment of a municipal art museum, the municipal government passed a special cultural district plan of Nei-Wei Pi to host the art museum. The plan of 1992 was passed with a set of urban design codes that made Nei-Wei Pi the first planned area with a designed vision in Kaohsiung.

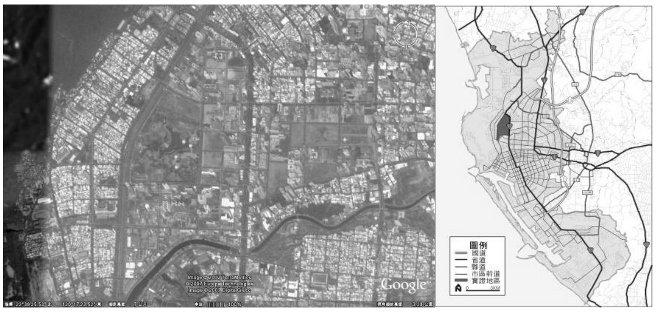


Figure 1*: the aerial view of Nei-Wei Pi (the shield –shaped area), left; and its location at Kaohsiung (the dark spot), right*

Since the pass of the plan on 1992, this district has endured three modifications of the site boundaries and the designs. The total land size amounts to 170.12 hectares today with 80 hectares of land slotted for building. As in early 2008, the building projects licensed have reached 209 cases (33.36 ha, 41.46 %); of these, 14% are 'super high-rise' buildings (more than 18 floors), 76% are high-rise buildings (below 15 floors), and the rest are duplexes and terraced houses (See Figure 2). However, even the place is not fully developed, a planned fiasco has emerged – "super high-rise" buildings can be seen erecting alone like castles surrounded by open spaces and/or lower building complexes (Figures 3 and 4) . Some of them are located facing large open spaces; some are located near narrow streets

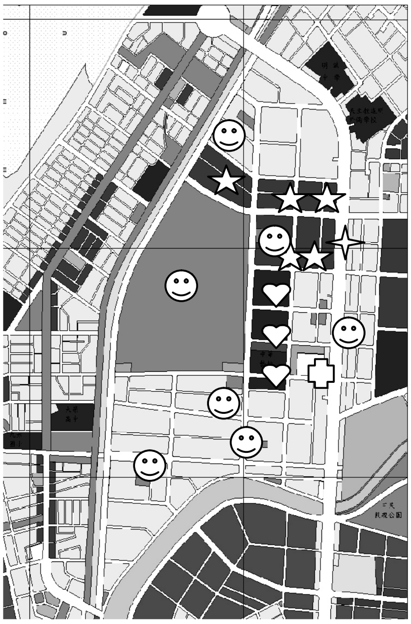
Figure 2: *A panoramic view of the field (from northeast)*

Figure 3: *A glimps of the site from southwest*

Figure 4: *Two more looks at the site from east*

3.2 Spatial Regulations and Design Codes

As we have argued earlier, conformance to the spatial regulations is one thing but the performance of each building project is another. In Nei-Wei Pi, not a single building project has attempted to violate the rules and every project is built to make profit. That leads us to the examination of the plan and its design codes for figuring out the gap.



Legend :

☆ Special Commercial Zone 4 (60%/ 630%)
✧ Special Commercial Zone 3 (60%/490%)
☐ Special Residential Zone 5 (60%/420%)
♡ School (40% and 6floor/6floor/8floor)
✚ Hospital(40%/400%)
☺ Park and Greens

Figure 5: *Land Use Plan of The Special Cultural District Plan of Nei-Wei Pi*

As ***Figure 5*** shows, the officially planned vision for this district is a 王-shaped road network within “the shield”, that is congregated by a huge park in the west, commercial buildings in the mid-north and east, and some schools in the middle surrounded by some residential buildings in the north, east and south. As a common practical strategy for Taiwanese planners, land-use zones are regulated by three rules: 1) only the blocks that face roads with 12+ meters in width can be commercially used; 2) land-use zonings shall all be regulated by both coverage rate and floor area ratio (except schools that have floor ceilings; and 3) unless necessary, the existing road system should be kept. As this convention goes, the major design codes for this district are the setback requirements for the 王-shaped road network, and some minor requests for green coverage, plant species and street furniture. It is under such external constraints that the builders performed their calculative project managements.

4. Performing building projects, constructing planned fiasco

The analyses that follow are performed in 3 stages. We first reviewed the development history of this area and collected secondary data from official construction records and compared the building projects. Secondly, we visited the site via several field trips and did visual analysis. Lastly, we interviewed selected developers to learn their construction strategies and managements. Because of the limitation of pages, the findings follow below.

Upon the passing of the plan in 1992, speculative *rentiers* rushed in to purchase lands. The price at that time was relatively cheap – approximately NT$200,000 per *ping* (one *ping* is approximately 3.3 square meter), so that the petite rich got small parcels and the super rich got big chucks. But the building boom did not get started until the late 1990s as the economy was still bad for investment, so that, in between, only some land transactions happened sporadically. Once the building market got the green light, those held the small parcels long enough and still had the money to invest started building detached houses, duplexes and apartments. The low buildings started to grow like weeds in random that signalled the beginning of those calculative performances.

4.1 Following calqulations, constructing markets

Conventionally, the homebuilders in Kaohsiung have established a set of vocabulary to classify their commodities: the *first-buyer*, the *changer*, and the *topper*. These monikers for the houses all have the targeted buyer attached to them. Because, over 80% of the Kaohsiung households have their own houses, that leaves less than 20% of market share. Therefore, the *first-buyers* are aimed to sell for the first-time homebuyers; they are usually designed to attract consumers with 25-35 of age, no children, affordable to pay 2-3 million NT dollars for a suite, two or three rooms (approximately 40 *pings*). Considering the prices of land are relatively higher in this area, the ideal typology for this kind of commodity is therefore the high-risers. It guarantees reasonable profits and the cash-flows as well as the construction time can be fast. The *changers* are targeted at consumers with maturity and financial stability, who desire more comfort and public facilities; and because they are experiencing changes in life circle, they are also seeking for changes of lifestyle. This kind of commodity varies from detached houses to super high-rises (roughly 60 to 70 *pings*); but, usually not in the high-risers. The super high-rises are the equivalent of the *toppers*; they are large-scale (100-200 *pings*), luxury, and expensive and they are to be sold only to the top echelon of consumers. This classification system is primarily the developers’ *market device*.

From the builders' distributed cognition of their customers, three building types were thus constructed; namely, the detached and duplex, the high-rise and the super high-rise. A rule of thumb (or a formula) was circulating in the builders circle saying that: "to build the first type, internal return ratio should be 13 plus or minus 3%, build it for no more than two years; to build the second and third types, the IRR should be 15 plus or minus 5, and they take 2.5 to 4 years respectively." The basis of the convention is purely financial, but the implication for spatial development is not easy to judge. Of the 209 cases we studied, the information provided in **Tables 1** and **2** shows their styles of management. In order to have enough units for their projected ideal markets, they would first disregard the zoning regulation. If the project site was located at commercial zones (i.e., SC4 and SC3), a design of the first floor to be stores would be implemented and the above would be designed to be residential. If the project site was located at residential zone, facing narrower streets, either a larger size of land would be purchased or the builder would reduce the coverage rate to make the buildings higher so as to show the massy image as a landmark. As for the setback regulations, they make senses for the detached and duplex house builders only. Cases located at the sites where more meters of setback are required decrease drastically. But, we can see no regularity among the high-risers and super high-risers.

Table 1 Relevant Spatial Information about the three types of houses

	Detached and duplex	High-riser	Super high-riser
Site			
Averagesize	1133m^2	2141 m^2	3660 m^2
Minimum size	71m^2	476 m^2	1327 m^2
Maximum size	8741m^2	6709 m^2	10396 m^2
Zoning			
Cases in SR5	119	48	8
Cases in SC3	1	5	0
Cases in SC4	8	0	6
Average CR used	87.14%	78.16%	61.99%
Average FAR used	47.14%	98.66%	99.98%

Table 2 Cases of the Three Types in Setback Locations

Meters required for setback from street front	0	4	5	6	8	10	Subtotal
Detached and Duplex	8	55	44	12	5	5	129
High-risers	0	22	17	8	7	12	66
Super high-riser	0	2	4	1	1	6	14
Subtotal	8	79	65	21	13	23	209

4.2 Bonded by lands, fleeting with value-added

Of the 209 cases we investigated, there are 81 builders involved. 48 among them constructed only one project then escaped. The remainders can be classified into two types: the generalists and the specialists. The specialists seem to be investing long-term in this area and some of them even have headquarters at one of their products. Not every specialist builders are so fond of this area; they stay put because they have already purchased too many lands. The specialists concentrate in building high-risers; most of them aim at the *first-buyers* and the *changers*, only three dedicate themselves to the *toppers*. The *topper*-builders' styles vary but each has its reputation in some symbolic aspects. In order to boost their business reputation, they use landscape design in every case; once they get awarded, the prices for their products get up-scaled immediately. As these three compete with each other frequently, they sometimes spend extravagantly to purchase some small adjacent lands to modify a project design to show off their tastes and capabilities. The seemingly most successful one just sold two units to the former President Chen Shui-Ban and became an immediate celebrity.

But, the generalists changed their building types frequently and their headquarters are all located outside. One of the generalists built the most and had 20 projects here, including all three types. This company owns a bank to finance its projects and all three types of their projects appear to be copied from their previous projects. It is still hard to predict for how long they will continue at here as the market started shrinking on the last couple of years. Only one thing is for sure that their projects usually conform to the official regulations and their internal designs.

In Table 3, we summarize the statistics of the builders' performances in Nei-Wei Pi in terms of scales. It shows no easy patterns to be identified; and, to decipher it requires more energy. But, this is how the builders in Nei-Wei Pi are performing; they have vivid vision in their minds that goes far beyond the planners' fascination. They calculate and they perform to the extent that they adapt to the environment they help creating and then survive.

Table 3 Some Statistics of the Builders' Performances in Terms of Scales

Builder Type	One-shot builders	Specialists in houses	Specialists in first-buyer's high-risers	Specialists in changers' high-risers
Average site size	1057.01m^2	1489.31 m^2	2778.20 m^2	3322.37 m^2
Minimum site size	217.68 m^2	153.76 m^2	1312.80 m^2	1278.56 m^2
Maximum site size	8741.11 m^2	3948.27 m^2	5091.00 m^2	10396.20 m^2
Average unit number	10	14	97	166

5. Concluding remarks

We started this investigation as we saw the disparity between planned visions and the developed realities becoming widened. Without blaming the incapability of the planners, we went straight to study the developers' project management. *En tour* to our appreciation of the builders' project managerial styles, we realized the differences between what Kenneth Burke termed "conceptual equivalent and reality" and the immensurability among a single developer's performing markets and the collective conformance to the official regulations. The space just self-organizes itself and mutates as multiple actors with different stripes engaging in envisioning it. It is our tentative suggestion that unless we have more understanding of the builders' performances in cultivating markets, all *good* city design discourses with different templates are deemed to be futile.

6. Acknowledgement

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A Framework of User-Based Design Satisfaction Measurement for Element School Construction

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ABSTRACT

Construction has typically been viewed as a manufacturing process in which the product of this process is the completed facility. The design performance for projects significantly impacts the success of a project and influences the project satisfaction of the client. This study develops a framework for measuring design satisfaction (DS) for elementary school construction projects using survey data collected in Taiwan. Factor Analysis (FA) was applied to analyze the collected data, extract and group the primary evaluation criteria. SPSS 12.0 was used to extract the major evaluation items associated with DS.

The proposed framework consists of three aspects (*Teaching space design, Campus planning and design*, and *Eco-awareness oriented*) and 19 DSEIs (Design Satisfaction Evaluation Items). *Eco-awareness oriented* was the most important aspect among the three DSEAs (Design Satisfaction Evaluation Aspects) when measuring the DS of school construction. Results of this study contribute to efforts to improve design satisfaction and quality of school construction projects. The framework, concepts, and methodology used in the study can be applied to build similar frameworks for other important aspects of construction and service performance for school construction projects.

KEYWORDS

Design satisfaction, school construction, evaluation

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1. INTRODUCTION

Satisfaction is a client's cumulative results of positive experiences; however, these positive experiences can be adversely affected by just one bad experience [Arditi & Lee 2003]. In increasingly competitive environments, satisfaction evaluation (SE) has become crucial to business success. Satisfaction evaluation research has garnered considerable attention recently. The SE revolution has spread to many industries, including the construction industry.

Generally, planning/design and construction phases of a construction project have the greatest influence on project success. Some researchers believe that the planning/design phase is the most important component in delivering a success project, and thereby deserves the most attention. For a construction project, architects are responsible for transforming needs and expectations into drawings and specifications. Contractors then transform these drawings into a construction entity.

Since elementary schools lack for professional construction personnel, the design and supervision of an elementary school construction is usually awarded to the same architectural firm or engineering consulting. Various design faults may be covered up due to the game-rule of players acting as referees at the same time. Improper designs are therefore often generated-and lead to problems associated with project cost, duration, quality, and safety [Lin & Chen 2005]. Additionally, the performance of Architect/Engineer (A/E), including their professional knowledge and service performance, significantly impact the success of a project and influence satisfaction derived from a particular project.

To provide client satisfaction of design, it is necessary to take the client's prime concerns of design performance into consideration. If designers fully understand a school construction project cleint's viewpoints regarding design performance, eliminating possible design defects and enhancing the project client's satisfaction is easy. However, what aspects the school construction owners concern and how well the designers perform in terms of school construction design are still remained unclear.

2. PREVIOUS STUDY

Construction satisfaction evaluation related studies cover a wide range of topics, from general conceptual guidelines to specific aspects. Only few were related to the design of a project. Investigated the design process problems of an office renovation project, Mitropoulos and Howell (2002) proposed mechanisms to reduce design rework and duration, and increase the quality of the design solution, including: (1) to accelerate the discovery of existing conditions, (2) to identify the project constraints that design and construction have to meet, (3) to select the project team early, and (4) to accelerate the iterative design process with a team-based rapid development of schematic design. Chang (2001) investigated cost/schedule performance indices (C/SPIs) and their values for design projects. According to Chang, the values and scores derived from the defined ranges effectively differentiate performance, meaning the C/SPIs and ranges are well defined.

Thomas et al. (1999) developed a conceptual model for measuring the productivity of design professionals during the contract document phase. The proposed model relies on the measurement of design output. It has been found that the measured productivity actually modeled design performance as various events disrupted the design effort. Hyun et al. (2008)

analyzed the impact of delivery methods (design/bid and design/bid/build) on design performance based on the construction drawings and specifications of public multifamily housing projects. Delphi and AHP were used to develop objective standards and contents for evaluating design performance. An analysis of variance test was also conducted to analyze which delivery methods would have an effect on design performance.

3. RESEARCH METHODOLOGY AND DATA COLLECTION

Via the viewpoints of school facility users/managers, this study aims to build a framwwork of model for measuring the DS associated with school construction. This study collects data for design SE of via a literature review, expert interviews, and a questionnaire survey. Factor Analysis (FA) was applied to analyze the collected data, extract and group the primary evaluation criteria. Several statistical analytical techniques were used to develop the framework of evaluation model. In this study, satisfaction is defined as "customer subjective appreciation after consuming products or services."

3.1 Research analysis tools

In this study, reliability analysis was performed to examine the stability and consistency of the questionnaire survey. A questionnaire with high reliability means respondents answered the same or similar questions with a certain consistency or stability. This study used Cronbach's α to measure questionnaire reliability. A high Cronbach's α indicates that internal consistency is high. This study uses content validity to assess questionnaire suitability to ensure that the survey has a sufficient number of samples and an appropriate distribution ratio [Nunnally 1978]. The communality of FA is used to examine construct validity.

Factor analysis uses few dimensions to represent the data structure and retain most of the original data. This study uses SPSS 12.0 for FA to extract the major evaluation items associated with design satisfaction. Principal Component Analysis (PCA) is used to extract the common factors in the questionnaire. The varimax method is utilized to extract the important factors via Orthogonal Rotation (OR). Cronbach's α was used in assessing the reliability of each aspect. The extraction of common factors should be based on the following criteria [Hair, et al 1998]: (1) eigenvalues of aspects exceed 1.0; (2) the loading of factors exceeds 0.5 and have a 0.3 difference from all aspects; and, (3) Cronbach's α exceeds 0.5. Additionally, the varimax method, a commonly applied method, can generate a factor structure that is easily interpreted. The factors extracted by the varimax method are mutually independent and, thus, can provide non-overlapping information.

3.2 Research data collection

A literature review was performed to identify the evaluation items for design satisfaction of construction projects. A list of nominated design satisfaction evaluation items (NDSEIs) for school construction projects was determined and reviewed by a group of personnel related to school construction, including architects, contractors, school Director of General Services (DGS)s, and county government engineers. Finally, a two-section questionnaire that obtained background information and assessed design satisfaction was developed to collect research data. Each item in section 2 represents one DSEI. Section 1 collects background information of the school construction project associated with respondents. Section 2 contains 19 items (representing 19 DSEIs). A Likert 5-point scale ranging from 1 for "extremely unimportant" to 5 for "extremely important," was used to measure responses.

A full-time teacher in the school, the school's DGS is considered one of the best candidates for evaluating school construction works due to their involvement in the construction project and teaching experience. The survey questionnaire was sent to the DGSs of 293 elementary schools with ongoing construction projects or construction projects completed within the last year. In total, 148 valid questionnaires were retrieved (50.51% response rate); this response rate is considered highly satisfactory for such surveys in Taiwan. The reliability of 19 DSEIs was validated using Cronbach's α. A Cronbach's α <0.3 indicates low reliability, whereas a Cronbach's α >0.7 indicates high reliability [Fowler 2001]. The Cronbach's α of the model and phases are >0.7, indicating high reliability (Table 1).

Table 1. Reliability of Model Aspects

Overall Cronbach's α	Aspect	Aspect Cronbach's α
0.944	Teaching space design	0.908
	Campus planning and design	0.888
	Eco-awareness oriented	0.787

4. BUILDING THE MODEL

4.1 Factor analysis and groups labeling

Factor analysis is a series of methods used to identify clusters of related variables and, hence, is an ideal technique for reducing numerous items into an easily understood framework. Factor analysis examines a data matrix generated by data for numerous individual cases or respondents [Chen & Chen 2007]. The first stage of FA involves determining the strength of relationships among variables, namely, the 19 DSEIs, measured by correlation coefficients for each pair of variables. Based on the statistics generated by SPSS 12.0, we conclude that the 19 DSEIs share common factors.

The Bartlett test of sphericity is 1656.613 and the associated significance level is 0.000, indicating that the population correlation matrix is not an identity matrix. Additionally, the value of the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy is 0.937, which markedly exceeds 0.5, thus is highly acceptable. The test results show that sample data collected by the study is suitable for FA.

Three clusters with eigenvalues >1 were extracted (Table 2). Each DSEI weighs heavily on only one cluster, with loading exceeding 0.5. Generally, loadings and the interpretation of the items extracted were reasonably consistent. Furthermore, the three clusters explained up to 61.76% of accumulated interpretation variance and, thus, are acceptable. These three clusters, labeled in accordance with DSEI attributes under them, became framework of evaluation model aspects. These three clusters are *Teaching space design* ($DSEA_1$), *Campus planning and design* ($DSEA_2$), and *Eco-awareness oriented* ($DSEA_3$).

Table 2. Group of Matrix After Varimax Rotation for DSEIs

DSEIs	Cluster 1	Cluster 2	Cluster 3
$DSEI_3$	.799		
$DSEI_1$	.771		
$DSEI_{10}$	.723		
$DSEI_7$	.696		
$DSEI_5$	.665		
$DSEI_6$	.635		
$DSEI_9$	.572		
$DSEI_{12}$		.701	
$DSEI_{11}$		.675	
$DSEI_2$		.649	
$DSEI_{13}$		.640	
$DSEI_{15}$		.634	
$DSEI_4$		.633	
$DSEI_{16}$		.545	
$DSEI_8$		.506	
$DSEI_{14}$			.783
$DSEI_{17}$			.641
$DSEI_{19}$			.633
$DSEI_{18}$			.544
Eigenvalues	4.616	4.075	3.044
Percentage of variance (%)	24.294	21.450	16.019
Cumulative percentage of variance (%)	24.294	45.744	61.762

4.2 Determining the weights of aspects

A stage-two questionnaire was used to determine the relative weightings of aspects. The paired comparison method, was utilized to measure the relative importance of aspects. Each aspect was compared with another aspect based on preferences identified by respondent questionnaires. The relative weight of one aspect compared to another can range from extremely significant (5:1) to extremely insignificant (1:5).

The stage-two questionnaire was sent to 75 individuals who returned the stage-one questionnaire. Fifty-one completed questionnaires were collected, representing a 68% return rate. A consistency test (homogeneity of fit) was applied to validate the 51 completed stage-two questionnaires. The consistency ratio (CR) of each returned questionnaire was calculated; questionnaires with CR values ≤ 0.1 were considered valid [Saaty & Vargas 2001]. In total, 31 completed questionnaires (61% of 51) passed the consistency test and, thus, were considered valid. The related weights of aspects were then calculated based on the 31 valid questionnaires.

Shown in Fig. 1, the relative weights of the three aspects were 0.265, 0.352, and 0.383, respectively. Furthermore, the relative weights of items beneath aspects were calculated using the Simple Additive Weighting Method (SAWM) based on the 148 valid stage one questionnaires. We conclude that the DGSs were mainly concern for *eco-awareness oriented* and *design of classroom auxiliary teaching facilities/utilization of green mateials design of classroom* in terms of DSEA and DSEIs respectively when evaluating the DS of schools.

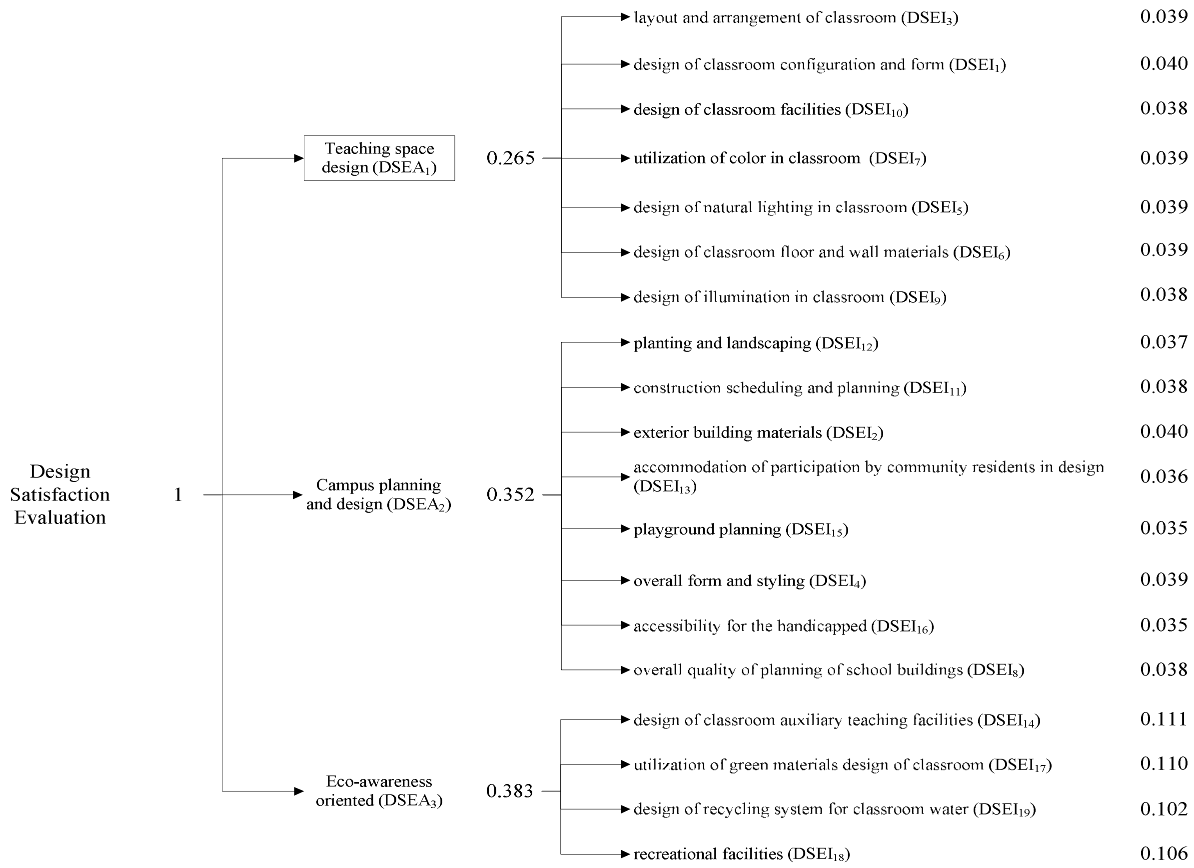

***Figure 1:** Main scheme of the proposed framework with related weights*

4.3 Procedure of evaluating DS

To assess the DS of a school construction project, a DSE table (Table 3) is developed based on the Likert 5-point scale, ranging from 1 for "unsatisfactory" to 5 for "satisfactory." Satisfaction evaluators simply ticked one of the five boxes (intensity of satisfaction; IOS) for each evaluation item based on their perspective on DS. Additionally, each school's DSG is the perfect candidate for assessing satisfaction as the DSG is in charge of construction works and teaches in the schools. The following procedure should be followed when DS of a school construction project is evaluated.

(1) Rate IOS

Each DSEI in the DSE table is rated in terms of its IOS on a 5-point scale, ranging from 5 for "satisfactory" to 1 for "unsatisfactory."

(2) Calculate DSEI score

The DSEI score (DSEIS) can be calculated using Eq. (1). The weights of an item (WOI) are obtained using SAWM.

$$DSEIS = IOS*WOI \qquad (1)$$

(3) Calculate the DSEA score

The DSEA score (DSEAS) can be calculated by summing all DSEISs within a specific aspect. The DS score (DSS) equals the sum of DSEAS multiplied by the weights of an aspect (WOA), as shown in Eq. (2). The WOA are obtained using the paired comparison method.

$$DSS = DSEAS_1*WOA_1 + DSEAS_2*WOA_2 + DSEAS_3*WOA_3 \quad \text{………………………(2)}$$

Table 3. Design Satisfaction Evaluation (DSE) Table

DSEA	DSEI	WOI Weight	Intensity of satisfaction (IOS) 1	2	3	4	5	DSEI Score (DSEIS)
Teaching space design ($DSEA_1$) (0.265)	layout and arrangement of classroom ($DSEI_3$)	0.039	☐	☐	☐	☐	☐	
	design of classroom configuration and form ($DSEI_1$)	0.040	☐	☐	☐	☐	☐	
	design of classroom facilities ($DSEI_{10}$)	0.038	☐	☐	☐	☐	☐	
	utilization of color in classroom ($DSEI_7$)	0.039	☐	☐	☐	☐	☐	
	design of natural lighting in classroom ($DSEI_5$)	0.039	☐	☐	☐	☐	☐	
	design of classroom floor and wall materials ($DSEI_6$)	0.039	☐	☐	☐	☐	☐	
	design of illumination in classroom ($DSEI_9$)	0.038	☐	☐	☐	☐	☐	
Campus planning and design ($DSEA_2$) (0.352)	planting and landscaping ($DSEI_{12}$)	0.037	☐	☐	☐	☐	☐	
	construction scheduling and planning ($DSEI_{11}$)	0.038	☐	☐	☐	☐	☐	
	exterior building materials ($DSEI_2$)	0.040	☐	☐	☐	☐	☐	
	accommodation of participation by community residents in design ($DSEI_{13}$)	0.036	☐	☐	☐	☐	☐	
	playground planning ($DSEI_{15}$)	0.035	☐	☐	☐	☐	☐	
	overall form and styling ($DSEI_4$)	0.039	☐	☐	☐	☐	☐	
	accessibility for the handicapped ($DSEI_{16}$)	0.035	☐	☐	☐	☐	☐	
	overall quality of planning of school buildings ($DSEI_8$)	0.038	☐	☐	☐	☐	☐	
Eco-awareness oriented ($DSEA_3$) (0.383)	design of classroom auxiliary teaching facilities ($DSEI_{14}$)	0.111	☐	☐	☐	☐	☐	
	utilization of green materials design of classroom ($DSEI_{17}$)	0.110	☐	☐	☐	☐	☐	
	design of recycling system for classroom water ($DSEI_{19}$)	0.102	☐	☐	☐	☐	☐	
	recreational facilities ($DSEI_{18}$)	0.106	☐	☐	☐	☐	☐	

The weight of the item (WOI) equals the weight of the aspect divided by the number of DSEI; DSEI = WOI *IOS. Each DSEI is rated ranging from 5 for "satisfactory" to 1 for "unsatisfactory."

5. CONCLUSIONS

This study established a framework for DS evaluation using questionnaire surveys and statistical analysis techniques. The DS evaluation model consists of three aspects (*Teaching space design*, *Campus planning and design*, and *Eco-awareness oriented*) and 19 DSAIs. The DGSs concerned with *Eco-awareness oriented* ($DSEA_3$) was the most important aspect among the three DSEAs when evaluating the DS of school construction. *Teaching space design* ($DSEA_1$) was more important than *Campus planning and design* ($DSEA_2$).

The proposed framework could be utilized to assess the DS of school construction projects. Evaluation results generated could provide school construction designers with a basis for professional services. The framework, concepts, methodology, and analytical tools employed in the study can be used to establish similar models of other important aspects such as costs, schedules, quality, and safety performance in school construction.

Future research can investigate software aspects such as service satisfaction of related personnel. Additionally, a feedback mechanism can be established to collect information regarding problems associated with facility use. Collected information should be forwarded to designers of school construction projects to avoid similar defects, and eventually enhance overall design quality of school construction projects. Moreover, this study established a framework for evaluating the DS of school construction projects; however, sophisticated DS evaluation models need to be developed, and the various standards of evaluation must be established.

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Managing the improvement of a city's public realm-

the case of Chiayi City's chief townscape consultant project 2005, 7- 2006, 12

Yu-Cheng Wu [1]

ABSTRACT

The project of chief townscape consultants was initiated by Taiwans' central government in 2003 to have urban design professions help local governments processing their townscape enhancement projects in accordance with central government policies. A team of planning and design professions, mainly from the NCKU, invited by the author, was organized to work for Chiayi City from July 2005 to December 2006.

The process was never smooth but the team managed to develop training courses, planning and design forums, and documents such as city-wide townscape improvement framework and suggestions for managing urban design control etc. They were welcomed by the city and did help related parties understand and work better on public realm design.

Two things are considered significant for the team to face the complexities of this consultant project and to come out with satisfactory results: the collaboration among different professions and a useful working mechanism based on contemporary urban design theories and principles.

This paper focuses on the management of this project. The team's initial expectation and working concept, and the way the team collaborated, will be discussed. The process of knowing the city, identifying urban design challenges and all the documents developed and forums and training courses responding to city's need is set against Punter's 12 general urban design principles to discuss its significance.

The key principles that guide the team through the various stages of the project are almost identical with that of management discipline and will be discussed in the concluding section.

KEYWORDS

public realm, townscape improvement, planning process and management, Chiayi City

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1. INTRODUCTION

The eighteen months consultant work, from July 2005 till September 2006, was considered successful not only that the required tasks were fulfilled and the public sector gave good responses, but also that the team did, through various efforts in different sectors, help the city understand better and improve the management of its public realm design.

Based on documents developed over the project period, this paper tries to set all related works and docements against Punter's general urban design principles [2006] and some general principles of management science [Magretta and Stone 2003; Ohmae 2005] to see the significance of the initial working concept and the way the project was managed. Planners and urban designers might be more interested in knowing the documents we developed; The author, who is also the project director, considers only when the team held strong professional aim and co-operated to face the complexity of the project can a satisfactory result be achieved. Management is no doubt one key to this.

Before exploring aforementioned principles, our working concept and some measures for management, the paper introduces first the project and the City of Chiayi.

2. PROJECT BACKGROUND, CITY PROFILE AND CHALLENGES TO TOWN-SCAPE IMPROVEMENT

The chief consultant project is part of Taiwan's townscape reform program, having planning and design consultant to help a municipality with its townscape projects. Given similar tasks, the challenges to such a team and the impact of their work differ significantly from place to place, owing to different local conditions and political and administrational support etc. After introducing project background and the city, this section outlines some challenges to our team.

2.1 Project Background

The so called townscape reform project was initiated by Taiwan's central government round 1999 to tackle some major urban problems in Taiwan's cities. It has become one major sector of Taiwan's recent urban design movement and has made significant changes to cities and towns all over Taiwan. A review mechanism with some design principles are developed to guide the development of local projects and a participatory planning process was emphasised.

Though over the years successful projects abounded, giving credit to this project and confidence to the initiators, quite a few projects did more harm than good to the public realm, visually and functionally and in major cities as well as in small towns. The idea of getting each city or county a chief townscape consultant was initiated in 2003. Expected most is that through the help of such a team a city-wide framework can be developed to offer workable vision and procedures for enhancement proposals and to knit individual projects together.

The former chief consultant of the City of Chiayi did help develop a framework pointing out clearly the city's physical character and opportunities for future development, namely the city centre- tourism axis, the cultural- tourism axis and the blue-green axis.

2.2 Profile of Chiayi City

2.2.1 Character of the City of Chiayi

Situates south of Taiwan and north of the Chia-Nan Plain, the City of Chiayi is a small city in terms of population size (around 273,000) and land area (60 square kilometers). It has a core area of densely built center with significant amout of mixed development surrounded by agricultural land and protected natural areas. Two rivers flow westward creating its northern and southern boundries and some water-side open spaces [Figure 1].

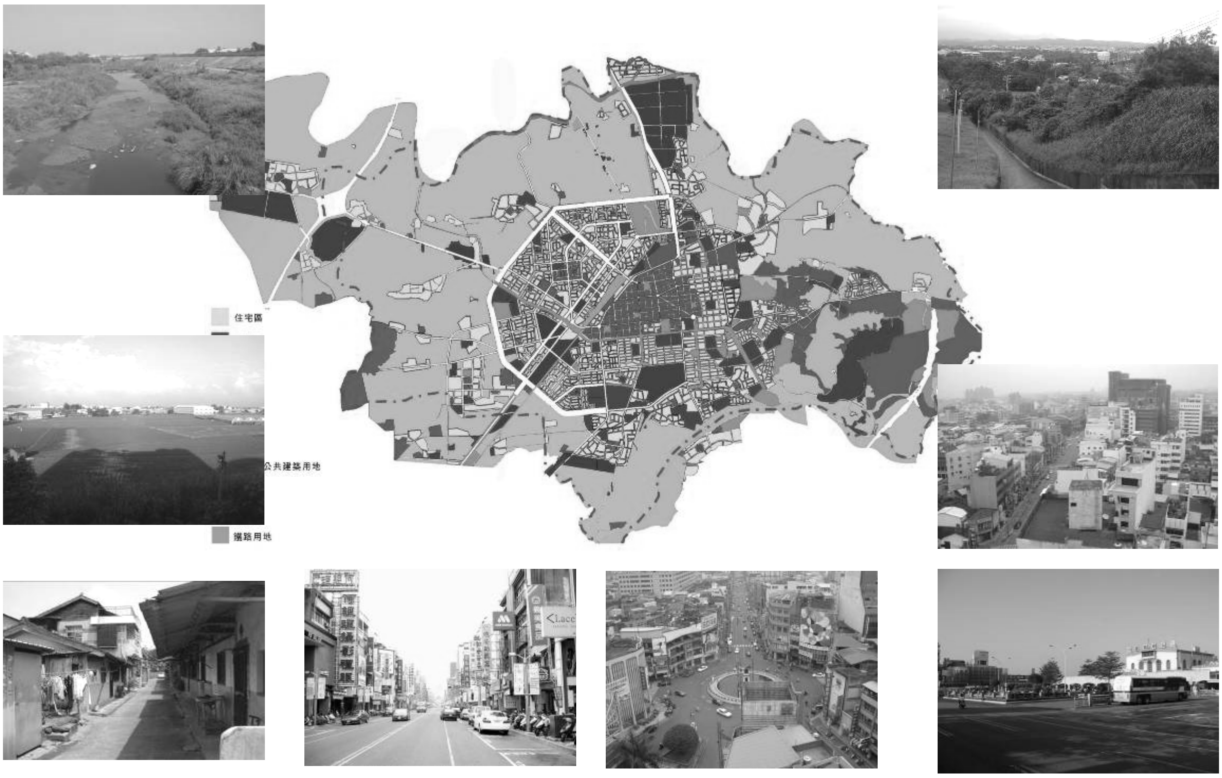

Figure 1. *Chiayi City's planning map with photos showing images of different districts*

Like most of Taiwan's cities, 'modern' city of Chiayi was planned and developed during the Period of the Japanese Occupation, creating a grid-iron road pattern with important public buildings on some nodal points. The city's characteristic wooden buildings were constructed during this period because of the cultivation of forests in Ali-mountain area.

Over the past two decades the city saw very little growth in population and economic capacity and suffered from the impact of land speculaiton and ill managed development over the early nineties. Its major urban design problems include visual chaos, pedestrian unfriendly public realm, ill-maintained environment, insufficient open space and parks, serious air and water pollution, poor public transport, and the losing of local character etc.

However, its interesting mix of town, villages and rural and natural districts within easy reach, rich physical and cultural assets and, importantly, its sound urban function with low urban pressure make it capable of being a nice place to live. The city has manifested itself and highly expected to be a city 'small and beautiful.'

2.2.2 Chiayi City's Townscape Reform Projects and Related Plans

Since 1999 the City has developed more than sixty townscape enhancement projects scattered about in the city. Nearly half of them are tree planting on major roads and park development. Others are enhancement to major streets and nodes and the development plans for some cultural-historic districts, and a few neighbourhood projects.

Still Chiayi's townscape reform cast very little impact on the city's visual, functional, or environmental quality [Figure 2]. Over the past decade, when successful experiences from Kaohsiung City, Hsinchu City, Yilang County and other places were well publicised, none of Chiayi's public realm projects gained notice. A strong wish for something new, commendable and relevant to the city's history was and still is often emphasized in project goals and in open discussions.

Figure 2: *Some of Chiayi City's townscape 'improvements'*

Based on the city's 1999 Comprehensive Development Plan, the former chief townscape consultant helped the city developed a Townscape Development Plan (2003), identifying three corridors for improvement. Also, since 1999 the city has developed some city-wide plans such as the Urban Design Structure Plan (1999), the Living Environment Reform Plan (1999), and City-wide Pedestrian Space Improvement Plan (2006). However, they cast very little impact and the city's public realm saw no significant 'reform'. As the chief planner of the city's planning department contended, most officials do not consult those strategic level plans when they prepared related environment projects [Hwang 2007]. Officials complained about the uselessness of those studies and plans; council members criticised about the very little contribution they done to the city's environment [Wu 2008].

2.3 Challenges to Chiayi City's Townscape Improvement

Apart from having to know the city in a short time, the team identified some other challenges for helping the city improve its townscape quality. After a series of field surveys, reviews of related plans and actual works, and knowing how the official members worked on related projects, we found firstly that the city needs an overall framework that not only positions individual project in the right place but also offers useful planning and design guidance; secondly, it needs a mechanism that officials can follow and work better on townscape projects; and thirdly it needs to develop an environment or culture that values, welcomes and encourages good design [Wu 2008].

3. THE MANAGEMENT OF THE CHIEF TOWNSCAPE CONSULTANT PROJECT

Aforementioned challenges were identified during the process of our consultant work. The rationale behind this was important. The team considered it important to help the city not only solve existing problems but overcome some structural barriers so that significant break-through can be made. The team believed that townscape improvement must have functional and environmental considerations as the support for visual quality. Successful designs respond to both physical settings and local needs appropriately so they attract people. What's more, they are often well maintained [Punter 1999; Carmona et al. 2003].

This section discusses how the team organised all related works and how works assigned and reviewed. Control of project schedule through regular meetings and the use of tables for control will be explored. Stage by stage tasks and outcomes will be introduced in the end to show the way the project progressed.

3.1 Concept of Project Management

The team's initial working concept was devised before the project started and was found significant and useful throughout the whole eighteen months [Figure 3].

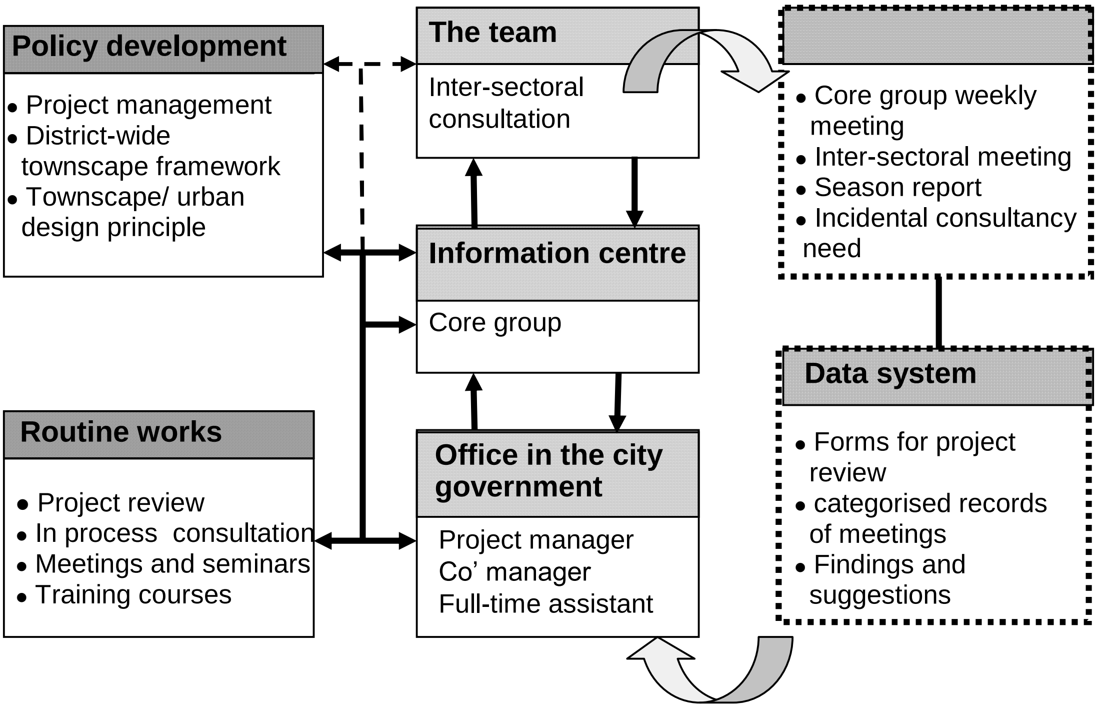

***Figure 3:** The working concept of townscape consultant project- showing nature of tasks, relation among actors, and information flow and control*

Three points are worthwhile emphasising here: the organisation and cooperation of the team, the separation of routine works and policy developments and the control of regular meetings and reports that help propel different sections of the project and establishment of a data system.

The director and two co-directors (an urban designer, a planner and an architect) and two assistants formed the core group, sharing survey, review and the development of design policies and responding to general project needs. Supporting consultants specialised in transport planning and management, tourism planning, green design and planning, urban conservation etc. helped offer general suggestions and review specific projects.

All works are divided into two groups: 1. routine works, such as project reviews and consultation meetings; and 2. policy level works, such as developing principles for reform projects and devising mechanism for up-lifting design awareness. The latter relies of course on identifying problems from the former and on supporting works such as site visits, review of major plans, case studies and consultations.

From the very beginning all members were asked to keep good records of every meeting or review each attended, covering issues and problems discussed and suggestions given. Standard forms and tables are developed for meeting record, site survey, and plan review etc. and all records were reviewed and collected by the core group. The core group met every Monday, reviewing past week work, in progress works and discussing proposed later actions. Policy level works will be discussed, routine works reviewed, and certain level conclusions made so that responsible personal and schedule can be arranged.

3.2 The Major Stage-by-Stage Tasks and Outcomes

The eighteen months can be divided into three sections. The first for knowing the city, including identifying general urban design problems; the second, offering general principles and guidance for project management; and the last, consensus and capacity building. Important meetings and conferences organised by the central government helped the team understand better our role and offered useful lessons from other cities and counties.

Organised in Table 1 are the key tasks and outcomes developed over the periods, while routine works are excluded. Altogether they contribute to four major parts significant to the improvement of the city's townscape improvement plans: *knowing the city*; *building consensus*, concerning the nature of public realm design and commitment to design quality; *developing principles* that would guide future projects; and *enhancing project management*, including better information system and in-time consultations.

Table 1: Major works and results of Chiayi's chief townscape consultant project through the years, divided into three periods

	Major works	*Results and documents*
1st and 2nd seasons	●City survey ●Consultant meetings（8） ●Review of relevant projects and plans ▲Development forum of 5 provincial cities ▲Forum of Chiayi's Urban development ●Case study- Portland Central City Design Guidelines ▲2005 Nation-wide space reform forum ▲2005 1st National Conference on Landscape/ townscape Structure Plans	●Results of survey (5/ table with images, issues and comments) ●Extracts of the city's major projects and plans (15) ▲Lessons from Portland's study ●Distribution of the city's 88-94 townscape reform projects, a map ●Notes on Chiayi City's townscape structure plan
3rd and 4th seasons	●City survey and review of former townscape reform projects ▲Case studies- Tainan City and Chanhwa City ▲Draft plan for Chiayi's townscape forum ▲Visit the mayor- the team of the chief consultant project and the team for townscape structure plan ▲Case study- Tainan City ▲96 townscape reform plan negotiation meeting (CPA, MOI)	●Result of survey- nodes and major streets（5） ●Extracts of city-wide plans（11） ★Three townscape projects management principles ★Concept plan for the city's townscape network ▲The city's first townscape forum ★Suggested framework for the city's townscape reform projects ■Stage by stage notes for the development of townscape proposals (project management) ■★End of first year report (Portland's experience/ Punter's general urban design principles)
5th and 6th seasons	▲Year 96 competitive project assessment meeting (Taipei) ▲Draft proposal for the second townscape forum ▲Plan for public sector staff training ●Updating the information of major projects ▲Yearly meeting of chief consultants (CPA, MOI)	▲★The chief consultant's special report: outline and lessons from year 96 competitive projects/ suggestions for Chiayi City ●Extracts of city-wide plans（2） ▲The second townscape forum ▲■Training course for townscape project ▲Report of 'Yearly meeting of chief consultants' ★■Suggestions for the City's urban design review ■Updated tables of major projects

CPA- Construction and Planning Administration; MOI- Ministry of the Interior
●Knowing the city; ▲Building consensus; ★Developing general principles; ■Enhancing project management

Tasks and outcomes in Table 1 are marked with different symbols representing their roles. The first two seasons were devoted to knowing the city, including city surveys, review of city-wide plans and consultations with local planners, concerned groups and professions. The result, organised as a townscape project map and a series of tables outlining project conditions, became a key document of Chiayi's townscape reform project. Later on more effort was devoted to developing general principles for townscape reform and enhancing management. Building consensus was a major theme throughout the whole periods.

Various efforts were tried to respond to the city's need while the team encountered, including offering lessons from case studies, developing principles for project management, and suggestions to Chiayi's Landscape Structure Plan etc. All those were later integrated into two important documents offered at the end of the first year: *general townscape improvement policies*, covering area-by-area environment issues, improvement concepts, development policies and planning and design principles [Table 2]; and a step-by-step *Notes for townscape project management*.

Table 2: Part of the suggested enhancement policies for the city's green network

Environmental issues	***Concept for improvement***	***Development policies***	***Development principles***
A-1-1 Scattered green resources	γ connecting, Diversifying, en-living green resources	γ defining roles of the resources so that later development can respond to	γ strengthening use support without compromising environmental concerns
A-1-2 The awkward roles of parks and botanical garden	γ differentiating areas for protection or for daily use	γ defining roles of different parks, boulevards, etc. responding to ecological concerns and need for daily uses	γ limiting human interferences to protected natural areas

Townscape forums and training courses were organised at the latter part of the project. They were considered important mechinism for consensus building and awareness promotion. Though it was welcomed in teh beginning and was arranged in the seceeding chief consultant project, the city did not develop its capacity to take charge such matters and have them held regularly.

Overall the team had been helping the city to develop design awareness and expertise. Through the processes of revising project contents and selecting designers, the team stressed the importance of encouraging design expertise and due consultation. However, there are strcutral barriers. Comparing with Taiwan's other cities such as Taipei, Kaohsiung or Tainan, Hsinchu, the city is seriously short of talented urban designers; and central government's funding system and schedule control discouraged reasonable time for planning and design analysis and the invitation of capable designers. Also harmful to the city's was (and still is) the two-tier system where projects not sponsored by the townscape reform project can be excluded from the 'interference' of the consultant team, rendering a careful contol of small projects while major constructions can well breach fundamental design principles.

Obviously, an overall townscape reform structure with sound design principles are needed; and project management has to be improved. However, no suggestions or plans will exert influence on the city's public realm unless they are incorporated into the existing policy framework or management system. [Punter 1999 and 2006; Carmona *et al*. 2003]

The last important document the team developed according to the city's request was a Proposal for Enhancing Urban Design Control, crafted for the city and based on Punter's general design review principles [Figure 4]. Suggested changes to the organisation of the Urban Design Review Commision and possible task arrangements to develop related documents and enhance targeted areas were also included (the grey part in Figure 4).

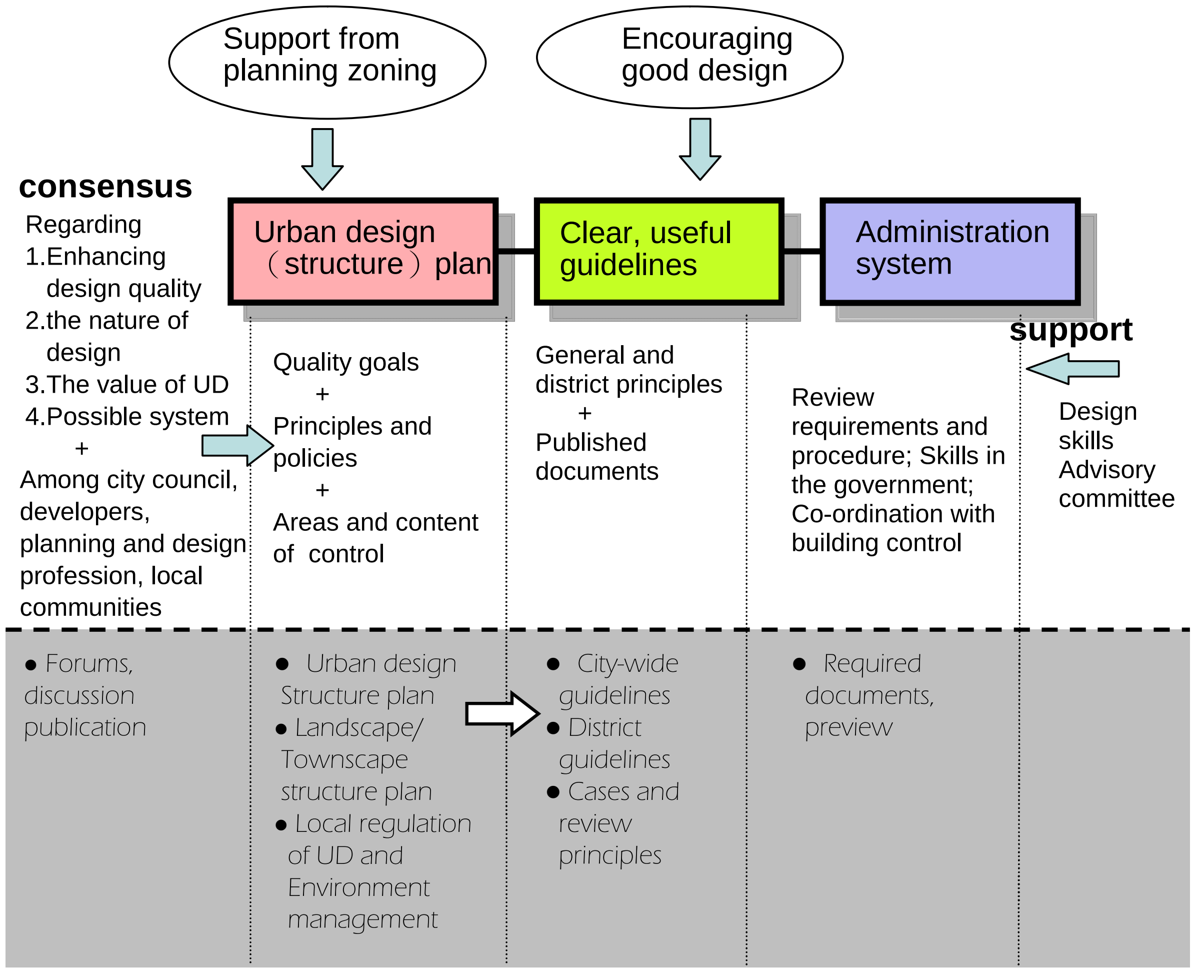

Figure 4: *A conceptual diagram showing principles and measures for better urban design review*

At the end of this project, the team convinced the city government to have the final report issued in a book format so that it can be widely consulted by the officials and the general public, avoidnig the fate of most thick project reports that ended up buried in file cabnit. Key materials of Chiayi's townscape reform projects, including important suggestions from the team, project review from the planning department, are included with most texts rewritten in a more plain language that the general public can understand.

4. FINAL DISCUSSIONS

It is always the hope of the team to see the city improving. Gladly, some suggestions did influence the city's urban design management, though significant 'reform' of the public realm has yet to come. The role of such a consultant and the way urban design academics involve in the city are worthwhile discussing.

Hsia sees Taiwan's urban problems- urban primacy owing to urban rural migration, booming of the informal sector, the disarticulation of value systems and the alienation of spatial experiences- the result of twisted economic development and industrialisation. He contends that a participatory urban design that helps foster a citizen society and the real use value of urban spaces the key to Taiwan cities' spatial and cultural reform [Hsia 1990]. Planning and design professionals have to come out of the limited roles of technique bureaucrats witnessed in Taiwan's planning history to challenge the existing planning, as well as political, system to participate in such a change [Chang 1993].

The County of Yilang's planning and design success demonstrates the importance of useful planning and design consultation that led the county to develop in a right way. Tseng [2004] contends that commitment to environment quality, administrational support, better conditions for architects' ingenunity, collaboration between public and private sectors, active local societies, added with strong sense of proud from all sectors, are factors for Yilan's success. Wu [2009] considers political support from political leaders and the general public the key to long term success. Yilang offers a platform where planning and urban design professionals can contribute because it values professional input. The existing planning system does not promise quality environment people now expect. Also not every city understands clearly the value of urban design and the importance of comprehensively involving quality concern in its planning system and development control.

Punter's suggestions for a planning system to deliver better design quality were developed after in-depth studies of best practices in the UK, the US and Vancouver [Punter 1997, 1999, 2003]. They respond to both zoning systems and discretionary planning systems and cover the following areas: community vision; design, planning and zoning; broad, substantive design principles; and due process (with respectively 2, 3, 3, and 4 principles). The efforts and outcomes of our consultant project fall in this frame, highlighting the importance of widening the concern beyond townscape to tackle problems under surface, especially the efforts of consensus building and changes to existing systems, to have real influences.

The team never knew exactly what challenges we'll encounter; neither did we plan to tackle project management issues in the beginning. Quite some efforts and ideas leading to later suggestions and actions were developed over the process. The key to this might be the team's initial concern for offering something new and useful and the wish to face structural problems rather than routine works. In retrospect, it is interesting to see all our efforts against Punter's principles and some principles of the management science.

The team was not a company doing the job for profit. We care for the quality of the city and we care for both the usefulness of our suggestions and that we develop our expertise. Appropriate management is no doubt significant to ensure efficiency and service quality. To tackle the unfamiliar works was challenging, but it was also encouraging to have them done decently with the help of related experts. The arrangement of manpower and the way all members shared works and developed all key documents together helped the success.

The eagerness to do a good job beyond the contract's requirements and so to have all directors working on the identified policy areas make this project distinct from the usual patterns seen in our planning schools. It is interesting to see this project from the view point of the management science. Magretta and Stone contend that the key to non profit organisations' management is not client but mission. Share values in an organisation helps significantly in successul management. Hsu emphasises the importance of mutual trust and enthusiasm for ideals as the base for real management [Magretta and Stone 2003]. Efforts in the first period of our project conveyed our concern for communication and building mutual trust. The key attitudes of professionalism advocated by Ohmae, namely caring for the customer (to us the city's public realm and the city's expectation), continual learning, daring to challenge existing norms, and willing to make a way through obstacles, were held by all members of the core group. What he identified as the key elements of professionalism- ability of foreseeing, ability to develop innovations and persuade, and ability to work with dilemmas- were the things we're forced to face [Ohmae 2005].

Other successful stories of townscape consultants' contribution to a municipality exist, but few talked about their project management. The processes the team went through, the way we manage to respond to the city's needs, the way we cooperated, and the various forms and tables we devised might be helpful for planners or urban designers tackling similar issues. We value the contribution of sound plans and good designs and contend again the importance of aforementioned professionalism which is the founding rock of planning profession and the key to our honour.

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The Externality of Building Violations in Urban Environment-Empirical Observation in Taiwan

Pong-Kuang Tseng [1]
Che-Ming Chiang [2]
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Chau-Yau Chen [4]

ABSTRACT

Building violations are currently one of the most important building management issues faced by all city and county government building authorities in Taiwan. The existence of widespread building violations in Taiwan may derive from the gap between "legal building usage," which means that a building has been legally constructed in accordance with the Urban Planning Act, the Construction Act, and the Building Code and Regulations, etc., and has obtained legal permits, and "reasonable building usage," which reflects the user's point of view about reasonable use of the building's space to meet the user's needs.

This paper takes cases of building violations in Tainan City as its empirical research subject, and classifies, analyzes, and compares the characteristics and influence of building violations in terms of the dimensions of time and space. Externality theory is used to explore the difference between "legal building usage" as prescribed in laws and regulations and "reasonable building usage" in the eyes of users. In addition, a questionnaire survey is used to gain an understanding of residents' spatial use needs and analyze the reasonableness of building spatial management laws and regulations, so that recommendations concerning appropriate building management strategies can be provided. Lastly, the hedonic price method is used to establish a hedonic price model for building violations, which is used to analyze the actual effects of the different building management strategies adopted by government, and provide recommended future management strategies.

KEYWORDS: Building violations, Externality, Hedonic Price, Taiwan

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1. Introduction

Possible problems about building management in urban areas mainly include building violations and usage violations, which is also one of the key subjects for the building authorities on building management. The so-called building violations mean all buildings constructed within areas carrying out urban planning, urban regional planning or areas applicable to the Construction Act designated by the Ministry of the Interior without receiving examination carried out by and the building permit issued by the building authorities. Said usage violations mean all applications in legal buildings violating the urban planning or non-urban land use control regulations in terms of nature or categories of usage.

Building violations still generally exist despite urban planning and building management codes in Taiwan at present. This may be due to the fall between "Legal Building Usage" and "Reasonable Building Usage". Said "legal building usage" means buildings are legally constructed according to the Urban Planning Act, the Construction Act and the Building Code and Regulations, etc. and have obtained legal permits. While said "reasonable building usage" means the space of usage of buildings are provided according to the personal demands and the natures of the buildings based on the viewpoints of the users. Should there be a consistent reorganization on both concepts, theoretically, there should be no building violations. However, the actual existence of building violations shows that the fall of a certain degree does lie between the both.

Therefore, the purpose of this study is to, through the analysis of externality, discuss how to propose appropriate management strategies according to the demands of the users from the aspect of laws and regulations according to the fall between the "legal usage of buildings" stipulated by laws and regulations and the "reasonable usage of buildings" from the aspect of the users. This study also tries to take Tainan City as the object to find out the fall between the legal usage of buildings and the reasonable usage of buildings through the data of building violations reports and the questionnaires on the characteristics of the demands of the residents for the usage of building spaces so as to educe proper and reasonable building management strategies and to explain the expected benefits of relevant strategies from the analysis on the eternality.

2. Externality theories and documents relating to building violations

The rapid increase in building violations in Taiwan is a thorny problem that government would like to resolve. Despite the many papers concerning this issue (Lai & Ho, 2001; Yiu & Yau, 2005; Yiu, 2005; Ho, 2007), there have been few empirical studies on the subject. Furthermore, most literature on the handling of building violations investigates the subject from the point of view of legal and administrative considerations, and there has been little discussion of the externalities produced by building violations.

In the discussion of Kuen-Tsing Shieh (2006) on building violations in Kaohsiung City, Taiwan, he proposed his viewpoints on the causes of building violations from aspect of law, society, economy and administration. Targeting at the treatment modes of building violations in Taiwan, Ting-Yi Lin (2005) pointed out in his study that, there are 6 main causes why building violations cannot be eradicated, including: Insufficient awareness of laws and regulations on construction of the people; Most people still have the mind of fluke or illegal lobby of elected representatives; Inability of existing laws and regulations to thoroughly and effectively punish building violations; The lack of outlays and manpower, failure of implementation of bans; Most citizens of Taipei believe that the existence of building violations will influence the rights of citizens and the overall residential environments; There's still flexible space left by authorities of Taipei City Government for the treatment of building violations. Hung, Tsun-Shan (2002) pointed out 5 points in his study including the treatment modes of building violations that the influence of building violations on residential quality and safety includes, he also provided 8 recommended modes for treatment of building violations including bidding for compulsory dismantlement, etc. Chiu, Hung-Che (2001) has proposed policies for treatment of building violations and divided them into two types of "Instructive" and "Banning".

3. Analysis on the features of the usage of building space by urban residents in Taiwan

In order to the features of the usage of building space by urban residents so as to explore the opinion of the users for "reasonable usage of buildings" and probe into possible causes for different types of building violations, this article analyzes the demands of users by collecting data on building violators surveyed by means of questionnaires on data of building violations investigated and reviewed. Moreover, in order to find out the externality of building violations, questionnaires have also been handed out to neighbors of building violators so as to collect data on the impact on physical environment of buildings.

3.1 Questionnaire

In order to fully compare the differences in the demands of building violators before and after full implementation of the capacity control, this study adopts the 8,304 building violators investigated in Tainan City in the 5 years (1992~2002) before and after the implementation of the capacity control (1997) as the targets and carry out sampling with the cooperation of registered households in different administrative districts, with the sampling rate of 3%, it has been estimated that 250 building violators would be sampled. However, due to the sensitive content of the questionnaire and the particularity of respondents, a high reject rate has occurred during our door to door survey, after repeated sampling continuously, altogether 2,716 replied have been received, which is less than 1/3 of all targets, including only 172 households as valid samples.

As for the questionnaire survey for impact of building environment on neighbors of building violators, one household was randomly sampled in the neighborhood of each building violator willing to receive the survey; therefore, respondents of the survey on neighbors of building violators were also 172. The questionnaire survey was carried out in the door-to-door mode during Jul and Sep of 2008.

3.2 Results analysis

3.2.1 Analysis on results of the questionnaire survey on building violators

Altogether 172 building violators were surveyed and the results are as follows.

a. Basic data of respondents

The respondents are during the age span of 41~60, mainly with the education background of junior or senior high school, most of them are commercial operators with the monthly income of below NT$ 40,000, families with 3~5 members take up a high proportion.

b. General survey of real properties of respondents

Most of all building violators surveyed have land and buildings under their own ownership (about 70%, see Table 1), with the land of building of about 36~99m², most of them have the structural area of 69-198 m², etc.. In term of building structure, most of their buildings are 1-store~4-store buildings, most are with 3~4 bedrooms, 2 halls, 2~3 bathrooms, 0~1 terrace and 0~1 parking space (See Table 2).

Table 1 Land and building title and area of building violators surveyed

Land title	Times	%	Building title	Times	%
Privately-owned	123	71.51	Privately-owned	120	69.77
Tenanted	49	28.49	Tenanted	52	30.23
Total	172	100.00	Total	172	100.00
Land acreage (unit: 3.3m²)	Times	%	Land acreage (unit: 3.3m²)	Times	%
Below 10	7	4.07	Below 20	1	0.58
11~20	19	11.05	21~40	22	12.79
21~30	51	29.65	41~60	16	9.30
31~40	12	6.98	61~80	10	5.81
41~50	8	4.65	81~100	11	6.40
Over 50	5	2.91	Over 101	17	8.14
Subtotal	102	59.30	Subtotal	77	44.77
Missing value	70	40.70	Missing value	95	55.23
Total	172	100.00	Total	172	100.00

Source: Investigation data of this study

Table 2 Overview of building spaces of building violators surveyed

Item	Stories		Bedrooms		Halls		Bathroom		Terrace		Parking space	
Number	Times	%	Times	%	Times	%	Times	%	Times	%	Times	%
0	0	0	17	9.88	24	13.95	10	5.81	86	50	108	62.79
1	31	18.02	7	4.07	38	22.09	32	18.60	49	28.49	53	30.81
2	32	18.60	19	11.05	103	59.88	55	31.98	16	9.30	9	5.23
3	40	23.26	40	23.26	5	2.91	42	24.42	12	6.98	1	0.58
4	43	25.00	47	27.33	1	0.58	19	11.05	5	2.91	0	0
5	16	9.30	19	11.05	0	0	7	4.07	2	1.16	0	0
6~12	6	3.48	22	12.78	0	0	6	3.48	1	0.58	0	0
Missing Value	4	2.33	1	0.58	1	0.58	1	0.58	1	0.58	1	0.58
Total	172	100.00	172	100	172	100.00	172	100.00	172	100	172	100.00

Source: Investigation data of this study

In term of parking problem in urban area, over 60% of building violators surveyed have no parking spaces, 30% have only one parking space each, according to our investigation, the car ownership rate in Tainan City as of the end of 2007 was about 245 cars/1000 persons, or about 0.73 car/household, therefore, the parking spaces of most building violators are highly insufficient, which may cause building violations or traffic problems like occupation of roads or parking violations, etc.

c. Analysis on the places of building violation of building violators surveyed

In term of location, most of building violations are of privately owned land (about 90%), in term of places, legal space (about 50%) and roofing (about 34%) are leading.
The cause checked the most by respondents is "Insufficient Space" (about 40%), "Unawareness of laws and regulations" follows (about 25%), near 25% have checked "others",

which, in detail, mainly include "existing building violations due to former owners" and "existing building violations in houses tenanted", etc.. From the fact that about 40% building violators surveyed have reflected "Insufficient Space" as the main cause, we can see that the building spaces of existing design of buildings are obviously incapable of meeting the demands of users. The weighted average on the basis of the statistical data of land acreage for buildings of building violators surveyed (See Table 1) is about 86m²/household, according to the members per household, it is estimated that in average, there're about 4.5 members in each household, if we calculate by the average capacity rate of 200%, the average living space for each person is about $38m^2$, which was slightly lower than the living space standard of 50 m^2 of urban planning. This may be one of the main causes of building violations due to insufficient spaces of building violators.

d. Analysis on the satisfaction for building spaces

In term of the usage and acreage of the overall building, about 1/4 (slightly lower) of all building violators surveyed have been unsatisfied. In term of specific building spaces, including the usage, acreage and quantity of rooms, parking spaces and kitchens, over 1/4 of all building violators surveyed have been unsatisfied, which shows a general trend of dissatisfaction of building violators surveyed for those spaces, which then resulted in building violations, such as building violation of the roofing, extension of rooms in quantity and acreage, violation of the legal spaces as well as extension of parking spaces and kitchen in acreage, etc..

The weighted average of the number of bedrooms per building violator is 3.4 according to the number of bedrooms shown in Table 2, and according to the average number of family members of 4.5 in the family of each building violator as mentioned above, each person holds only about 0.75 bedroom in average, which may easily result in building violations.
In term of satisfaction for parking spaces, each household in Tainan city owns 0.73 car in average, about 1 car per household, from the cross analysis of the quantity of parking spaces and the satisfaction for parking spaces we can see that 48 building violators surveyed are unsatisfied, near 65% (31) are families without cars, the other 35% (17) have 1 parking space each. This shows that in term of the economic capacity of residents in Tainan City, it is general that each household owns 1 car, however, due to the expensive land price, the land acreage of each building unit is too small, it is hard to design sufficient parking spaces, which therefore leads to the problem of utilizing legal spaces as parking spaces.

3.2.2 Analysis on the results of the questionnaire survey on neighbors of building violators

Altogether 172 neighbors of building violators have been surveyed in this study, the purpose is mainly to learn their opinions on the impact of building violators on physical environments of buildings, and the results are shown below.

a. Basic data of respondents

The respondents are during the age span of 41~60, mainly with the education background of junior or senior high school, most of them are commercial operators with the monthly income of below NT$ 40,000, families with 4~5 members take up a high proportion.

b. Analysis on the impact of building violators on physical environments of buildings

The survey is carried out on neighbors of building violators to learn their opinions on the impact of building violators on physical environments of building including: public safety, urban landscape, rights and interests of the others, sound environment, light environment, thermal environment, air environment, water environment, green environment, vibration environment and electromagnetic environment, etc.. When asked on the impact of building violators on various environments, many respondents considered that the impact is great on "public safety", "urban landscape" and "rights and interests of the others", with over 40% having checked "Impacted"; in term of physical environments of relevant buildings, it is possible that some people are not so sensitive to the change in physical environments of relevant buildings, the proportion of respondents checking "Not Impacted" is higher than that of those checking "Impacted".

4. Analysis on Strategies of the management of building violations externality

4.1 Strategies of the management of building violations externality

As for solutions of externality problems, different measures should be taken according to different subject factors of externality, comparison of objects to levy on, objective of levy and standard of levy from different aspects. Basic concepts include "paid by users", "paid by beneficiaries", "growth payment", "return of added value" and "special common levies", etc. Objectives of levy adopted include internalization of external costs, recycling of facility costs, reducing development impacts and levying on gains from alteration without pains. Those should also be applied to the actual strategies on land development, including Burden of redeemed land in urban land readjustment, Impact fee for non-urban land development and air pollution prevention fees, etc.

However, for the externality relationship resulting form building violations as well as the differences in their impacts, different management strategies should be taken for the treatment of externality. There are two causes of building violations, one is that the laws and regulations on construction may to too strict to allow users to get sufficient building area while complying with the existing laws and regulations; the other is the people's insufficient awareness or indifference to relevant laws and regulations. Results of the questionnaire survey on building violators also show that among all causes of building violators, "Insufficient space" is the main cause of most building violators surveyed, however, "Insufficient space" is mainly caused by expensive land price in urban areas and the reduction of floorage due to the implementation of capacity control, making it hard to realize the per capita living space specified in existing urban plans, the result is that users can only extend their living spaces by building violations. In this case, if the externality derived from the building violations of building violators is not so serious, it may be feasible and reasonable to levy compulsory impact fees on building violators for building violations. In the future, by amendment of urban plans and relevant laws and regulations on building management, the capacity control in urban areas may be relieved as proper so as to improve the living quality of people, and by reviewing relevant standards on parking spaces, problems like building violations and violations of traffic rules may be avoided or reduced.

For suggestions on treatment of building violations externality, the study mainly focuses on the impacts of externality, i.e., impacts on public safety, urban landscape, rights and interests of the others and urban physical environment, and then, considering legal factors and factors of users, researches to propose corresponding management countermeasures. According to the questionnaire survey on neighbors of building violators, most neighbors of building violators consider "public safety", "urban landscape" and "rights and interests of the others", etc. as main externality impacts of building violations, and that the impact on other urban physical environments are slight. Therefore, for management strategies, existing laws and regulations on the treatment of building violations should be taken as the basic spirits, corresponding management countermeasures include: 1) Compulsory dismantlement; 2) Improvement within limited period; 3) Levying of impact fee.

4.2 Compulsory impact fee

The foregoing discussion of externality strategies in building management indicates that the collection of impact fees for different types of building violations is an effective means of internalizing the external costs of the building violations, while also improving the urban environment. If impact fees are collected, however, what standards should be used to set the fees?

In order to establish a guidelines for the setting of fee assessment standards, this study used basic information from building violator respondents, along with the location of the building violations of each respondent building violator (urban or suburban area, taking 10,000 persons per square kilometer as the dividing line for administrative areas within Tainan City) and the type of building violation as the independent variables. In addition, the study also employed regulations governing fines assessed on unauthorized construction (building violations) in Articles 25 and 86 of the Building Act and the building construction price standards announced by Tainan City in 2001 (see Table 3). After using the building violation type, structure, and area for each building violator to estimate construction cost, the fine due was calculated as 50 one-thousandths of construction cost in accordance with Article 86, Subparagraph 1 of the Building Act. The amount of fine was used as the maximum willing-to-pay price for each respondent building violator, which constituted the dependent variable. The hedonic price method was then used to establish a maximum willing-to-pay price hedonic equation for building violations.

Table 3 Tainan City Building Construction Cost Standards

Construction type	Unit price (NT$/m3)
Steel frame or reinforced concrete, 2 floors or under	4,000
Steel frame or reinforced concrete, 3-5 floors	5,000
Steel frame or reinforced concrete, 6-10 floors	6,000
Steel frame or reinforced concrete, 11-15 floors	8,700
Steel frame or reinforced concrete, 16-20 floors	9,300
Steel frame or reinforced concrete, 21 floors or above	10,400
Reinforced brick	3,900
Brick	2,800
Wood	2,800
Brick and wood	2,800
Brick and stone	2,800
Steel construction with walls	3,500
Steel construction without walls	2,400

Source: Tainan City Government

With regard to the establishment of a maximum willing-to-pay price hedonic equation, economy theory does not provide any specific recommendations concerning the form of a hedonic price function. The form of this function chiefly depends on the cause-and-effect logic of the various influencing factors, and must take the goodness-of-fit of the dependent variable following estimation into consideration. In addition, the model must comply with economic analysis and yield reasonable empirical inferences. The flexible function form only taking into consideration the best fit may not necessarily be the optimal function form. Past research on application of hedonic price functions found that the function can have linear, semi log, inverse semi-log, or double-log forms. In addition, a Box-Cox transformation form may be employed, where the function form can be testing using the data fit. However, Cassel & Mendelsohn (1985) criticize the Box-Cox transformation function on four grounds: (1) Use of the Box-Cox transformation function to estimate a characteristic coefficient will weaken the correctness of any single coefficient estimate, leading to invalid hedonic price estimates. (2) Negative number data cannot be used. (3) The Box-Cox transformation is not suitable for prediction. (4) The Box-Cox transformation makes the estimation of slope and elasticity more complex in the case of a non-linear transformation.

In light of the problems affecting the Box-Cox transformation, this study attempted to establish linear, exponential, and logarithmic function forms, and ultimately determined that a hedonic equation with an exponential form yields the best results. After deriving the natural logarithm, the general form of the hedonic price method is:

$$\ln(P_i) = \hat{\beta}_0 + \hat{\beta}_1 \cdot x_{i1} + \hat{\beta}_2 \cdot x_{i2} + \cdots + \hat{\beta}_j \cdot x_{ij} + \cdots + \hat{\beta}_k \cdot x_{ik} + \varepsilon_i \quad (1)$$

In equation (1), Pi is the maximum willing-to-pay price of each respondent building violator, and $\chi\ ij$ are the relevant attributes influencing the maximum willing-to-pay price of building violator *i*. The results of parameter estimation using the foregoing equation are shown in Table 4.

Table 4 Hedonic Price Regression Model for Building Violations

Variable name	Parameter value	Standard deviation	t-value	Level of significance
Constant term	8.881**	0.487	18.238	0.000
Household size	0.155*	0.084	1.841	0.069
Legal space building violation	-0.946**	0.354	-2.673	0.009
Roof platform building violation	-0.627*	0.358	-1.750	0.083
Light-absorbing shade building violation	-2.948**	1.401	-2.104	0.038
Surrounding wall building violation	-1.298*	0.694	-1.869	0.065

Note 1: "*" indicates that the null hypothesis of 0 can be rejected when the level of significance α =0.1;

"**" indicates that the null hypothesis of 0 can be rejected when the level of significance α =0.05

Parameter estimation results indicate that the model's overall goodness-of-fit (revised R^2) for the maximum willing-to-pay price for building violations is only 0.079, which is certainly not good. This reveals that many factors affecting the maximum willing-to-pay price have not been included in the current empirical model. In the current hedonic price model, factors affecting building violators' maximum willing-to-pay prices, such as household size, whether a legal space building violation is involved, whether a roof platform building violation is involved, whether a light-absorbing shade building violation is involved, and whether a surrounding wall building violation is involved, are all significant. This displays that while the empirical model can still be used to perform cause-and-effect analysis of these variables, it cannot be used to explain variation in maximum willing-to-pay price.

The parameter estimation results in Table 4 show that only household size has a positive coefficient, which indicates that the greater the household size of a building violator, the higher the violator's maximum willing-to-pay price. Since the empirical hedonic function in this study is ultimately determined to be an exponential function, the elasticity of the effect of variable x_j on the maximum willing-to-pay price P is as shown in equation (2).

$$\frac{\partial P}{\partial x_j} \cdot \frac{x_j}{P} = \beta_j \cdot x_j \tag{2}$$

This shows that the magnitude of elasticity is correlated with the estimated coefficient β_j, and is also correlated with the independent variable x_j. This is used to calculate the elasticity of the effect of household size on the maximum willing-to-pay price P. If average household size in Tainan City is estimated to be approximately 4 persons, the elasticity coefficient will be approximately 0.62. When one household member is added (i.e., the household size becomes 5 persons), the elasticity coefficient will increase to approximately 0.775. Taking the average willing-to-pay price for the entire sample to be NT$16,479 (with a standard deviation of 27,242), compared with a household containing four members, the building violation opportunity cost (avoiding immediate removal of illegal structure with payment of a fine) is NT$2,554 for a household with four members. In other words, the opportunity cost increases by approximately NT$2,554 each time one more member is added to the household.

The fact that the variable parameter values for other kinds of building violations are all negative indicates that the greater the parameter value, the higher the corresponding maximum willing-to-pay price. Roof platform building violations had the highest willing-to-pay price, followed by legal space building violations, surrounding wall building violations, and light-absorbing shade building violations in that order. Taking the estimated coefficients in this study's empirical model as a basis, roof platform building violations have a greater opportunity cost of approximately NT$2,404 compared with legal space building violations; legal space building violations have a greater opportunity cost of approximately NT$3,636 compared with surrounding wall building violations; and surrounding wall building violations have a greater opportunity cost of approximately NT$1,898 compared with light-absorbing shade building violations. These results can provide the government with a basis for determining building violation impact fee standards.

5. Conclusions and Suggestions

It is found through the analysis of the study on the features of existing building violations in cities of Taiwan: (1) Under existing laws and regulations, during 1984~2007, the quantity of building violations reported in Tainan City has been increasing year after year, especially 1996, when Taiwan announced the full-scale capacity control, which shows that the capacity control did impact users of buildings. (2) In term of “type” of building violations, building violations of legal clearance is still the main type of building violations in Tainan City, the reservation of legal clearance is an important regulation for maintaining urban environment, especially “urban light environment”, “urban thermal environment”, “urban air environment”, “urban water environment” and “urban green environment”, however the people generally lack in this consciousness. (3) It can also be found through the questionnaire survey on building violators that the main cause for the building violations of ordinary people is insufficient spaces, at present, under the capacity control, the actual living space standard has not yet reach the standard specified in the urban plan, which makes people to extend their space of usage through building violations of legal spaces or roofing platforms. Therefore, further discussion is required to decide whether to relieve the capacity control when complete supporting facilities are provided in the future.(4) As for externality problems due to building violations, following the principles of social equity and efficiency, responsibilities of the externality should be borne by producers of the externality, therefore, it is necessary to discuss the externality of building violations by classification, different externality should be subject to different treatment.

The article holds the viewpoint that building violations may cause externality impacts on public safety, urban landscape, rights and interests of the others and urban physical environment, etc., and has discussed the relationships and impacts and proposed recommended management strategies, including Improvement within limited period or compulsory impact fees, etc. When discussion the possibility of the levy of impact fees, this article established the Hedonic Price function of the maximum willingness of building violators to pay for fines of building violations, the results show that the opportunity cost of building violation increases along with the increase in family members, as for the opportunity cost of different types of building violations, that of building violation of roofing platforms is the highest and that of legal space goes next. This result may be provided to public sectors as reference for establishing relevant standards on levying impact fees to internalize the external costs of building violations.

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Southern Taiwan Science Park's Policy for Sustainable Eco-Science Park

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ARSTRACT

To construct Southern Taiwan Science Park into a leading sustainable eco-science park in the world, the Southern Taiwan Science Park Administration(STSIPA) call the park enterprises, such as Delta Electronics Inc. and TSMC 14 FAB (awarded as USGBC. LEED Gold-rating Green Building) to construct a sustainable science park, in accordance with the aforementioned promotion program.

STSIPA is implementing several projects now , such as "The Whole Planning for Sustainable Eco-science Park, " "Study and Design of the Green Building Indicators for the Southern Taiwan Science Park's Plants, " and " Green Building Promotion Program." . And the workshops and visits will be arranged by April, 2009, a related seminar in June, 2009 and completion of all result in November 2009. It is expected that the Southern Taiwan Science Park will gradually become the model for eco-science parks in the sub-tropical climate.And STSIPA could get the USGBC. LEED-ND.

KEYWORDS：

Ecological science park , sustainable environment , Green Building indicators

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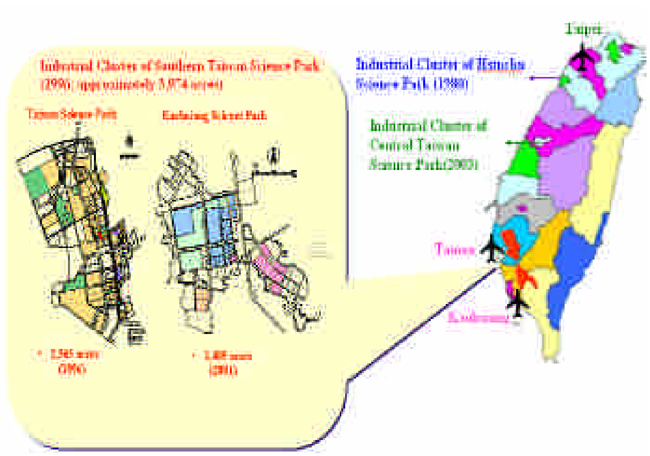
1. INTRODUCTION

Taiwan's science parks are a drive for economical development and are devoted to the development of high-value added and innovative technologies. Hsinchu and Central Taiwan Science Park, both with the temperate climate, and Southern Taiwan Science Park, with the subtropical climate, comprise the land of about 4,000 hectares and are expected to reach the turnover of 3 trillion dollars by 2011.As a result of the success of Taiwan Science Park in Hsinchu, the Executive Yuan of Taiwan addressed "the installation of Southern Taiwan Science Park" in 1991. National Science Council followed orders from the Executive Yuan to set "Southern Taiwan Science Park" in Feb. 1995, set the "development the preparatory office in Southern Taiwan Science Park" carries on the investment introduction responsibly, handles the Science Park's scheme and the development transport business and so on in 1997. Later, tenant demands spilled into unceasingly, 80% of the land that supply to put up factories had been hired, and to elevate status to establishment "Southern Taiwan Science Park Administrative Bureau" in 25th Jan. 2003.

Southern Taiwan Science Park is including Tainan Park and Kaohsiung Park, the development period regulation is from 1996 to 2010, the total funds are 8.3517 billion dollars, comprise the land of about 1,608 hectares, including the land about 1,038 hectares in Tainan Science Park that provided 527 hectares Industrial land, the land about 570 hectares in Kaohsiung Science Park that provided 207 hectares Industrial land (Picture 1,2)

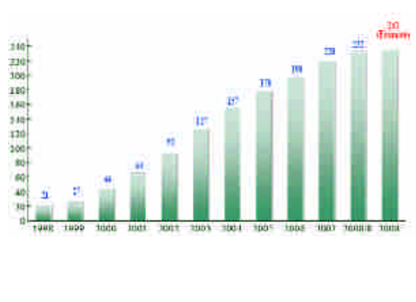


Picture 1: Introduction to Taiwan's Science Parks.
Sources: STSIPA

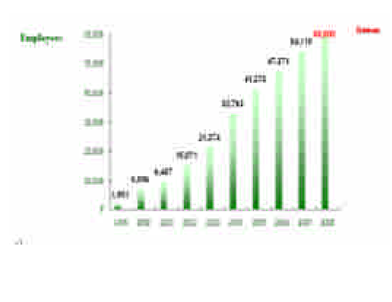
Picture 2: Southern Science Park in Tainan bird's-eye view.
Sources: STSIPA

In 2008, manufacturers introduction present situation are 243 (Picture 3), Foreign Tenant Companies at the Park: 15 Japanese Companies, 6 American Companies, and 1 German Company；Major foreign companies include Corning, 3M, APPLIED MATERIALS, SAFC Hitech Taiwan, SUMIKA, Finex, International Nitto, NEC Lighting, Intelligent Research (Chisso), ULVAC, Yaskawa, and Busch in the park.

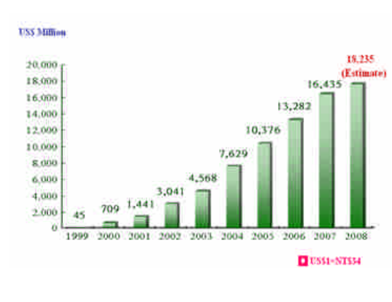
Working population are more than 55 thousand workers.（Picture 4），More job opportunities are created upon the establishment of the Southern Taiwan Science Park. Approximately 70% of the employees are from the Southern Taiwan Based on Taiwan's experiences to develop science parks, a full-time job opportunity provided in the science park brings three more jobs in the nearby area. Annual production value is more than 550 billion dollars.（Picture 5）。



Picture 3: Cumulative Number of Approved Companies by Year Sources: STSIPA



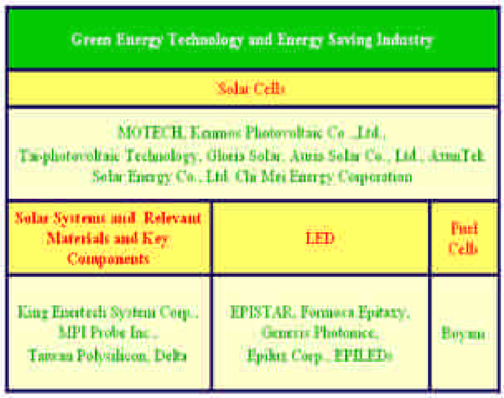
Picture 4: Growth Trend of Workforce Sources: STSIPA



Picture 5: Growth Trend of Turnover Sources: STSIPA

And Green Energy Technology and Energy Saving Industry，Make the best use of the advantages of the STSP's optoelectronics, IC and precision processing equipment industries. Develop solar cells, fuel cells, and LED lighting. 5 new tenant enterprises were approved in 2007, investing US$270.4 million (71.5% of total investments)，(Picture 6, 7)。

Picture 6: Green Energy Technology and Energy Saving Industry Sources: STSIPA



Green Energy Technology and Energy Saving Industry		
Solar Cells		
MOTECH, Kenmos Photovoltaic Co.,Ltd., Tai-photovoltaic Technology, Gloria Solar, Auria Solar Co., Ltd., AnnaTek Solar Energy Co., Ltd. Chi Mei Energy Corporation		
Solar Systems and Relevant Materials and Key Components	LED	Fuel Cells
King Enertech System Corp., MPI Probe Inc., Taiwan Polysilicon, Delta	EPISTAR, Formosa Epitaxy, Genesis Photonics, Epileds Corp., EPILEDs	Boyam

Picture 7: Industrial Clusters Sources: STSIPA

Southern Taiwan Science Park in Tainan has finished the main roads system and public facilities. The factory owners have built and carried on business the factories. The buildings in STSP are gathered in Nanke North Road to Nanke South Road 50 meters, the position is by the side of a boulevard. In construction, at first the factories and the officers had been built, they were transferred to promote to build the way of quality life. To go through of the earlier days of the dormitories and the building built, to near future of the Southern Taiwan Science Park in Tainan started using the centers of the communities, healthy centers, commercial service buildings and restaurants. Southern Taiwan Science Park in Kaohsiung is followed by the model in Tainan, continued to drive public constructions and attract commercial dealings.

The park appeals ecology, landscape that is emphasized by the quality of living. Not only function ecology recovery and to emphasize environmental protection, but also expected to combine the shape of the communities. According to the way the city design to purchase production, ecology and life three purpose in the perfect environment.

2. Taiwan and STSIPA Green Building policy

2.1 Eco-City and Green Building impetus plan

Taiwan is the 4th country to enforce the evaluated certification of Green Building, and the1st country in 3 parts: bring Green Building into public buildings, rebuild the old official buildings by government, regulate Green Building rules in construction legislation in the world. The Executive Yuan of Taiwan approved "Eco-City and Green Building impetus plan" in 12th Jan. 2008 and the general objective is to response the the global warming and urban heat island effects, impels the ecology city and Green Building positively to reduce urban heat island effects and to reach the goal of the national territory continues forever to construct. Inferior goals are included (1) handles can the area or the traditional block continues forever the environment transformation and lower urban heat island effects (2) promote and publicize the ecology cities, blocks and the concept of Green Building, and offer the prize and the subsidy to help those in need (3) to heave the skills of interior environment and establish the establishment mechanism that creates comfortable healthy and the high quality habitable area (4) Strengthens the construction to save the energy, carries out the greenhouse gas decrement (5) reward groundbreaking Green Building design and also has the building Green Building improvement in order to broaden ecological environment benefits.

The expectation carries out by the surface level to an level from city, community, building body, indoor quality combine" continues forever to develop the circulation system" and correspond with the Executive Yuan prompts "the impetus ecology community city to continue forever" the direction, complies with "the international tendency" and "acts as circumstances permit" the demands；estimated that in 2011 this plan handles completes， every year may reduce the CO2 withdrawal 270,000 tons.

2.2 STSIPA's goal

STSIPA in order to construct the Southern Taiwan Science Park to become the leading world to continue forever the healthy ecology science and technical park, coordination the Executive Yuan's policy of "ecology city Green Building impetus plan" above, handles "the green Building impetus plan, "continues forever the healthy ecological science park corporate planning" and "the workshop green building appraisal target draws up in Southern Taiwan Science Park" in 2009. The statements as follow:

2.1.1 Green Building impetus plan

In coordination with Ministry of Interior" strengthens the green construction impetus plan"，entrusts Republic of China Construction Academic society，holds the Green building guidance conference，the subject subscribes is "continues forever LOHAS Green Science Park"，Southern Taiwan Science Park in Tainan in Mar.，aims at the International Experiment Middle School teachers and students, the community residents and the campus manufacturer separately and is related the entrepreneur to hold three Green Building guidance meeting，Southern Taiwan Science Park in Kaohsiung in Apr. The standard workshop conducts the Green Building guidance to meet and to handle the campus and the domestic fine green Building case visit, Summarizes as follows:

2.1.1.1 16th Mar. the lecture of the continues forever of the campus（Picture 8）

In view of National Nanke International Experimental High School teachers and students that invited Chia Nan University of Pharmacy & Science Department of Environmental Engineering and Science Professor Shu Jen Ching，continues sustainable campus idea to discuss the issue of" The 21st century high quality campus new viewpoint - Sustainable Health LOHAS "，and to realize that although understands the school building is the teachers and students moves the time long place，the important attribute which in the school building the ideal campus is actually for moves the teachers and students who felt comfortably. Including vision, sense of hearing, sense of smell, sense of touch and so on. The proper green space may give the student the health the visual environment；the careful generatrix plan and hedgerow sound-insulated design can reduces the student from the noise disturbance. If the campus base can be helpful each kind to the teachers and students in the school life project, with plans attentively carefully in the limited space, then the campus then can be long-time，that is the goal of the continues forever the campus.

2.1.1.2 17th Mar. the conference of" continues forever the community to build"（Picture 9）

To the community residents in Nanke community center that invited National Pingtung Institute of Commerce Professor Kuei Feng Chang to discuss in "the sustainable community" concept and Eco-village: the case of ecology in the suburbs, and "the construction evolves again, community reactivation "and take the Da Kuang community and Shui Chung community in Heng Chun country for example. May take Taiwan in the future the rural area development perhaps the community restoration profiting by observing others

Picture 8: National Nanke Experimental High School's auditorium Sources: STSIPA

Picture 9: 3F meeting room in Nanke community center Sources: STSIPA

2.1.1.3"Sustainable LOHAS . Green Science Park" Southern Taiwan Science Park in Tainan, Green Building guidance meeting on 24th Mar.（Picture10、11）.

In view of the scientific and technical park manufacturers and the related jobholders, the administrative bureau guidance "Sustainable LOHAS ,Green Science Park" Green Building idea in STSIPA. Administrative bureau chief Chun Wei Chen declared to the world that Southern Taiwan Science Park is Carrying out Green Science Park's determination and estimate that to get USGBC LEED-ND（LEED for Neighborhood Development Rating System）Authentication in two years.

This time we invited Professor Hsien Te Lin, Department of Architecture, NCKU, Professor Fang Ming Lin, Department of Wood Science and Design, NPUST and TSMC LEED Team Chiang Tse Chen and the exterior team that provide the campus manufacturer to understand that current continues forever the health Green Building tendency, forecast of the green construction of operation practice and the Green Science Park. And branch factory F14P3 (obtains American LEED gold level Green Building authentication and Taiwan EEWH on this company diamond level green construction marker) to share the green construction management and the managerial experience.

Picture 10: South Science Park Administrative Bureau chief Jun Wei Chen delivered a speech
Sources: STSIPA

Picture 11: attending distinguished guests all group photo
Sources: STSIPA

2.1.1.4 " Sustainable LOHAS . Green Park" the promotion of Green Building in Kaohsiung Science Park, Southern Taiwan, 3 April.

To further discuss the issue of Sustainable LOHAS: Green Park, we invited professor Shian De, Lin from Department of Architecture of National Cheng Kung University and Green Building investigator s from Taiwan Architecture Building Center to introduce the prospection of green factories in Taiwan, model cases of Green Building in the world, an introduction to and application procedures for Taiwan's EEWH and the issues of BIPV' s development t and application. The meeting was expected to provide the companies in Parks with the understanding of present Sustainable Green Building tendency and policy.

2.1.1.5 visits to Parks' and domestic model green buildings

Except for the briefing in writing at the promotional meeting, companies were able to visit model green buildings in the Park to understand the design of green buildings. Location in the morning: TSMC 14 FAB Building P3 (awarded as U.S.A. LEED Gold-rating Green Building, Taiwan Diamond-rating Green Building) (as in picture 11, 12) and Delta Electronics Inc. (awarded as Taiwan Gold-rating Green Building) (as in picture 13). Due to the completion of the bicycle lane at Tainan Science Park, Southern Taiwan, bicycles were used as shuttle buses to get to green buildings.

Take shuttle buses to the Main Stadium for The World Games 2009 in Kaohsiung (awarded as Taiwan Gold-rating Green Building). The main stadium is to be inaugurated in May for the purpose of World University Games and to become a very important visit site for Green Building in Taiwan.

	
Picture 11: TSMC 14 FAB Building P3 Sources: STSIPA	**Picture 12:** visiting TSMC 14 FAB Building P3 Sources: TSMC
	
Picture 13: Delta Electronics Inc factories Sources: STSIPA	**Picture14:** visiting bicycle route Sources: STSIPA
	
Picture 15: green buildings in the Park to be visited Sources: STSIPA	**Picture 16:** the Main Stadium for The World Games 2009 in Kaohsiung Sources: STSIPA

2.1.1.6 The Park Guide Map of Green Buildings and Construction of Official Site for the Plan

The Executive Yuan of Taiwan stipulates that if the capital of a public construction is more than fifty million dollars, the company should obtain the certificate of Green Building before the construction begins and acquire Green Building Logo after the completion of the construction. In then Southern Taiwan Science Park, TSMC has obtained Taiwan Diamond-rating Green Building Logo (awarded as U.S.A. LEED Gold-rating Green Building), Delta Electronics has obtained Gold-rating Green Building Logo and Kaiser Pharmaceutical

CO., LTD. has obtained Silver-rating Green Building Logo. Hence the Park will make the Park guide map of green buildings and try to connect every model case of the green building with green transportation- bicycle lane.

	
Picture 17: the Park guide map of green buildings Sources: STSIPA	**Picture18:** Bicycle lane in the Park Sources: STSIPA

2.2 The Whole Planning for Sustainable Eco-science Park, Study and Design of the Green Building Indicators for the Southern Taiwan Science Park's Plants and so on

The STSIPA's routine promotion of Green Building is to examine whether the company follows the green-building-related regulations. In 2007 the sixth floor of the administration building became the model center for IAQ in Southern Taiwan. The building is able to oversee the concentration of CO2 and provide fresh air properly to maintain the quality of indoor air. Also, in 2009 STSIPA administration received a 3,500,000-dollar grant from Architecture and Building Research Institute, Ministry of the Interior. The grant-in-aid is to improve related air-conditioners and facilities.

Except for the above-mentioned programs, in order to achieve the goal of becoming the best green science park in the world, in 2009 STSIPA asked experts to make two plans; the Whole Planning for Sustainable Eco-science Park and Study and Design of the Green Building Indicators for the Southern Taiwan Science Park's Plants.

The Whole Planning for Sustainable Eco-science Park, the criteria for park planning and the comprehensive survey in the future, is to plan parks and cities in accordance with the requirements of the evaluation for Eco-city, such as the whole transportation in the Park, renewable energy and the use of land. And Study and Design of the Green Building Indicators for the Southern Taiwan Science Park's Plants is in relation to the detailed design for the construction of plants and construction levels. The construction of plants should meet the requirements of the evaluation, such as energy saving (including water and electricity) and indoor environment quality. And the Study and Design of the Green Building Indicators for Science Park's Plants are to be made according to Taiwan's subtropical climate to be the basis for the design of future cities and the building evaluation. STSIPA will combine Park companies that have obtained the certificate of Green Building to construct a sustainable science park, in accordance with the aforementioned promotion program.

April's progress: the project referred to information from the weather station in the Southern Taiwan and surveyed the Park's physical environment. The buildings in the Park spread from the North to the South, with the spread of land and farms in the East and the West. The area has a low density of buildings. With proper planning, it's likely to effectively control the climate in this area and reduce the effect on nearby area. Heat-absorbing plants built because of the requirement cause this effect. The test result is analyzed below:

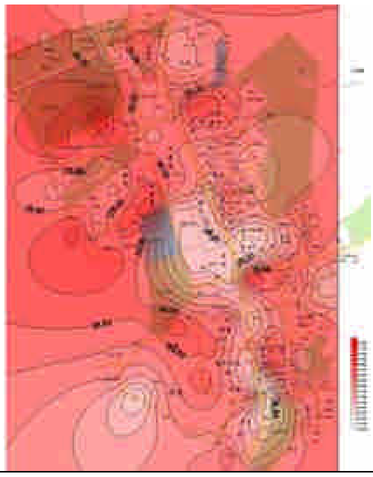
Analysis of the test result of the Park, daytime:

Daytime temperature: Chi Mei (plant land 4), HannStar, EPISTAR(plant land 7), CTimes (plant land 10), Kenmos (plant land 24), the Taiwan Power substation and so on with high temperature; the plants in plant land 12 and 9 with lower temperature. It's speculated that the two plants' low temperature is due to the two wide wooded area in the West. And the relatively high temperature in those areas is caused by the developing parks' lack of vegetation. (As in picture 20)

Daytime humidity: It's about 40~55 %, which is generally low. The outdoor staff feels comfortable. Plant land 1 with water a treatment pool and plant land 12 with a park in the West are in the higher-humidity area. Humidity in areas with plants is within average range and that of areas with roads is higher. It's thus clear that the distribution of water areas has a clear influence on nearby environment. The Park has sufficient sunshine; hence the highest of outdoor humidity in the daytime is around 60%, within the range that human body can feel comfortable. (As in picture 21)

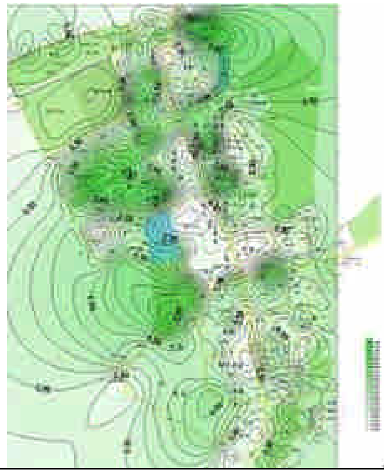
Daytime wind velocity: commercial land 2, plant land 4, plant land 7, plant land 34, plant land 33, South part of public utility land 15, public utility land 20 and so on with higher wind velocity of 0.8~1.1m/s and the daytime average wind velocity in other areas in the Park is 0.5m/s. It's speculated that the Park's surroundings are gradual and has wide distribution of farms and water pools. Consequently, in the seasons with less effect of the monsoon, the temperature gradient in this area is not obvious; hence higher wind velocity won't happen. In terms of outdoor environment, the wind velocity in the Park won't have too much influence on the outdoor staff. (As in picture 22)

Picture 19: aerial photos of the Park and the numbers of measure points Sources: STSIPA



Picture 20: the contour line for daytime temperature Sources: STSIPA

Picture 21: the contour line for daytime humidity Sources: STSIPA



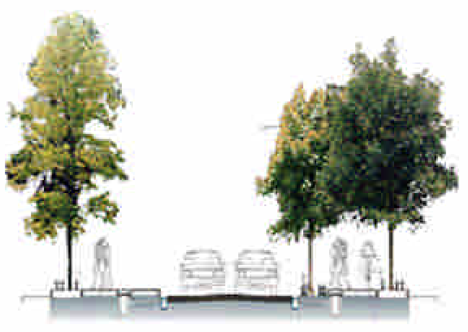
Picture 22: the contour line for daytime wind velocity Sources: STSIPA

Analysis of the test result of the nighttime Park:

Nighttime temperature: Picture 23 shows that nighttime temperature is between 15℃~24℃. In this area, the temperature difference between daytime and nighttime is up to 8℃. The possible reason is that the Southern Taiwan Science Park is mainly surrounded by farms and water pools. As a result, nighttime temperature drops faster. TSMC, plant land 33, plant land 34, ChopMOS, Chi Mei, plant land 9、plant land 12、environmental protection facility land2、public utility land 5、public utility land 15、水6、public utility land 29 are surrounded by water pools and wooded land and the temperature drop obviously. In public utility land 13 、plant land 25、plant land 24、institution land 2、plant land 23、plant land 21、plant land 20、plant land 26, the temperature is obvious lower as a result of the connection of wooded area. Temperature in plant land 2、plant land 1、plant land 4、plant land 5、environmental protection facility land 1 、transformer substation land 1 is clearly higher as a result of urban heat island effect. (As in Picture 23)

Nighttime humidity: This picture shows that nighttime humidity is between 65%~95%. The actual daytime and nighttime test shows that nighttime humidity is clearly higher. Nighttime humidity in the whole area is over 80%, which means that the number of surrounding water pools and farms affects the change of humidity in the Southern Taiwan Science Park. Humidity in plant land 3、plant land 34、public utility land 6 is relatively higher because of water pools. Humidity in green land 26 is relatively lower and humidity in the Park is obviously high in the nighttime without sunshine.

This picture indicates the wind velocity range is between 0m/s~0.5m/s. Obviously, the wind velocity in the nighttime is slower and weaker than in the daytime. The possible reason is that the stronger daytime convection causes higher wind velocity. On the other hand, the weaker nighttime convection weakens wind velocity. All in all, in the nighttime the Park hardly has wind velocity, except in , plant land 35 which is resulted from temperature gradient. (As in Picture 25)

<table>
<tr><td></td><td></td></tr>
<tr><td>Picture 23: the contour line for nighttime temperature
Sources: STSIPA</td><td>Picture 24: the contour line for nighttime humidity
Sources: STSIPA</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Picture 25: the contour line for nighttime wind velocity
Sources: STSIPA</td><td>Picture 26: the Park guide map of the linking system between small scale service roads and bicycles
Sources: STSIPA</td></tr>
</table>

Study and Design of bicycle lanes and mass transportation system: the principles of the Ministry of Transportation and Communications are energy saving and the increase in safety efficiency, short-distance transportation and human and eco-system-oriented transportation. (As in Picture 26)

Future goal: the plan is in progress, the Southern Taiwan Science Park is now aimed at sustainable health and energy saving and carbon reduction. The short-term goal is to finish the Whole Planning for Sustainable Eco-science Park and Study and Design of the Green Building Indicators for the Southern Taiwan Science Park's Plants as the planning criteria for future parks, the comprehensive survey, city design and the building evaluation. The medium-range goal is to obtain Green Park Logo in Taiwan and to learn from TSMC's experience of acquiring USGBC LEED for Neighborhood Development Rating System. The final goal is to improve every aspect of the Southern Taiwan Science Park, making it the model eco-city and the sustainable leading science park in the world

Utilizing CASBEE to Assess Kaohsiung Modernized Comprehensive Stadium

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Che-Ming Chiang [2]
Po-Cheng Chou [3]
Kuei-Feng Chang [4]

ABSTRACT

Promotion Sustainability is one of the great challenges facing humankind. CASBEE (the Comprehensive Assessment System for Building Efficiency) is a system for evaluating and ranking buildings in terms of their environmental performance. This paper utilizes CASBEE to assess Kaohsiung Modernized Comprehensive Stadium, trying to discover the different regional conditions in technical tectonics and standards.

KEYWORDS

CASBEE, Sustainable Building Assessment, Kaohsiung Modernized Comprehensive Stadium

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1. INTRODUCTION

Sustainable building assessment tools transfer abstract concepts of "sustainable building" into numeric forms that are easily understood, measures or signs that can be described and provide participants relating to various building environments with valuable information on building and environmental performances. A complete sustainable building measuring tool or assessment system can provide comprehensive quantitative information of buildings, reflect the impact of different stages of lifecycle on environment, society and economy, help identifying and solving problems and reduce the costs of construction, operation maintenance and management.

This study is intended to utilize the sustainable building assessment tool CASBEE developed by international experts, actually participate in system operation in accordance with local cases and propose diversified regional research outcomes under global standardized environment assessment organizations. The results reflect that regional development of sustainable building will gradually be achieved through the research and application of cases as well as best practice and guidelines.

2. Introduction of Japanese CASBEE Assessment System

Among all international sustainable building environment assessment tools, CASBEE is famous for its special calculation method – the "BEE (Building Environmental Efficiency)". Now we'll introduce the development, content and assessment results of this assessment system so as to further master its connotation.

(1) Origin and assessment content:

CASBEE[1] (Comprehensive Assessment System for Building Environmental Efficiency), researches related to which were released by professor Iwamura Kazuo, et al in 2002, is an assessment system with full set of assessment structure and connotations developed by Japanese integrated system of enterprises, governments, educational institutions and institutes and some cooperators referring to the GBTOOL experience promoted by the international sustainable building conference in combination with the cooperation and joint development of enterprises, governments, educational institutions and institutes[2] to accelerate domestic growth of sustainable building, the latest version was launched in 2008.

CASBEE adopts the opinion of building environment efficiency (BEE), as shown in the formula below, i.e., the value of products or services carried by unit environment, to assess the impact of buildings on load of external environment. The nominator Q means the "building environment quality and performance" within a supposed closed area; The denominator L means the "load of building environment" outside of the supposed closed area.

$$\text{BEE} = \frac{\text{Building environment quality and performance (Q)}}{\text{Building environment load (L)}}$$

Figure 1: *BEE calculation formula of CASBEE*

[1] CASBEE, the abbrieation of Comprehensive Assessment System for Building Environmental Efficiency, the famous evalution tool of Green Architecture advanced by IBEC Japan.

[2] K.F. Chang, 〈A Study on Adapting the Sustainable Building Environmental Assessment Tool for the performance of buildings in Taiwan〉，P.16，Doctoral Thesis of Architecture Department, NCKU. 2005

There are 3 application scopes and types of assessment dimensions for CASBEE: residential dimension, building dimension, urban dimension; there are 4 kinds of basic tools for assessment3 according to different stages of lifecycle of building.

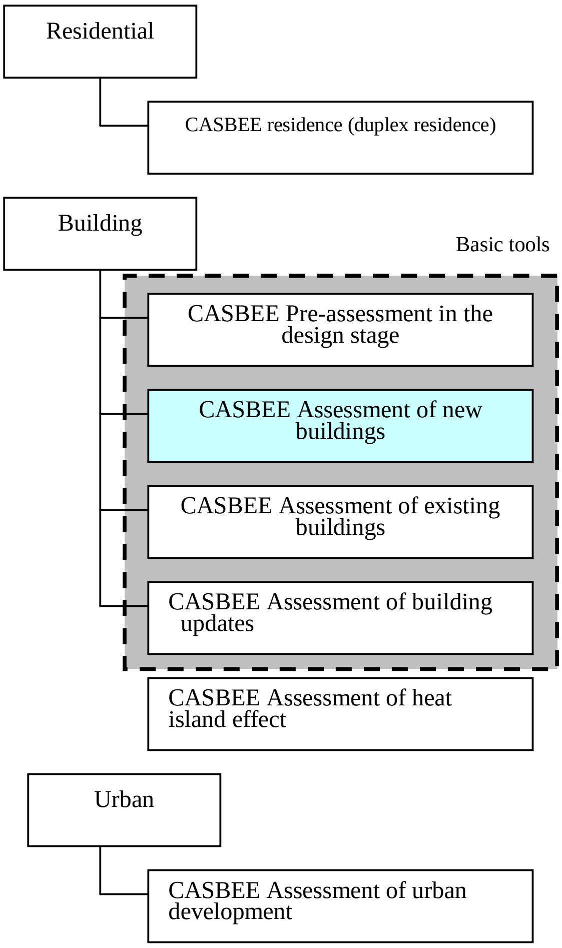

Figure 2: *Classification of CASBEE assessment tools*

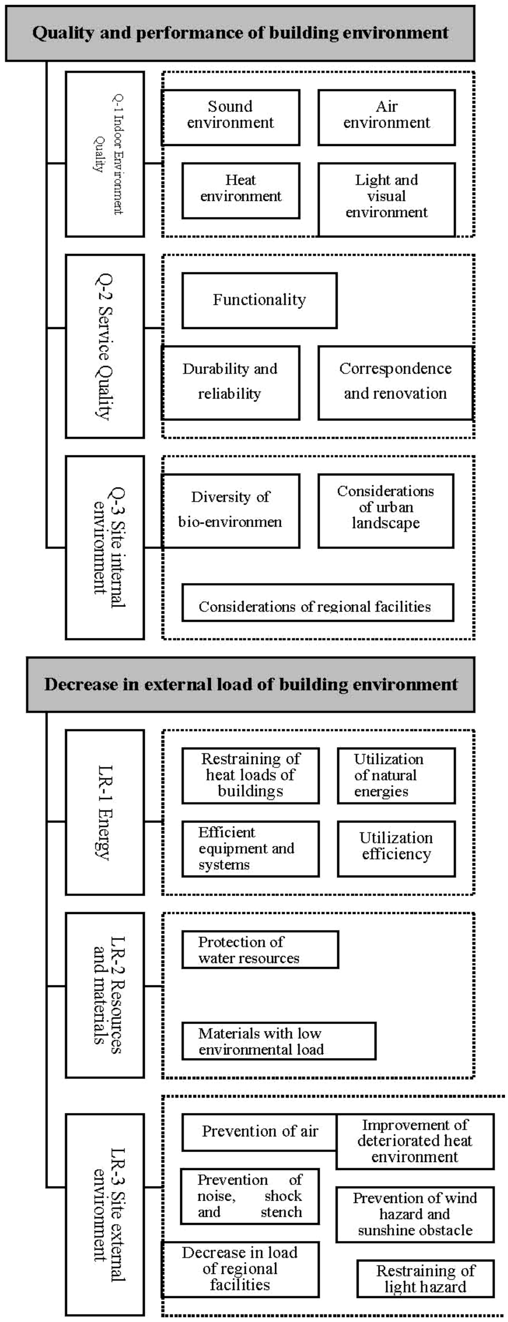

Figure 3: *Assessment structure of CASBEE-NC*

(2) Description of the CASBEE-NC adopted in this study:

This study is to adopt CASBEE-NC (new construction) to assess the operation outcomes of Kaohsiung Modernized Comprehensive Stadium, the description will be given below

[3] IBEC,《CASBEE for New Construction Technical Manual》,2008

according to the assessment groups and items of CASBEE-NC: items under the assessment group “building environment performance and quality (Q)” of CASBEE-NC include “Indoor Environment Quality”, “Service Quality” and “site internal environment”; items under the assessment group “external environment load of building (LR)” of CASBEE-NC include “energy”, “resources and materials”, “site external environment” .

3. Introduction of Kaohsiung Modernized Comprehensive stadium

Kaohsiung Modernized Comprehensive stadium is also called the “Kaohsiung Big Egg”, the so-called “Big Egg” is actually the abbreviation of the “Big Entertainment and Gold Games”, which clearly indicates its intention to provide multifunctional entertainments and wonderful competitions.

(1) Site environment and the main building:

The site of Kaohsiung the Big Egg is located in the sports-oriented land in Aozidi urban planning area of in Zuoying District, Kaohsiung City, belonging to Sin-Bo Section of Zuoying District, it connects Sinrong Street on the north, abutting by San-Min Home Economics & Vocational High School on the south, Huasia New Residential Quarter to the west and Bo’ai 2nd Road on the east, the site is about 264m long from east to west and about 250m from south to north, forming a trapezium with the total area of 57,376.66m². This project has selected two sites, in view of the lowest negative environmental impacts, the site has originally been located in Jhongjheng Interchange of Kaohsiung City, however, considering that this area is located near the Jhongjheng Interchange of Sun Yat-sen Freeway, which may cause traffic impact on the surrounding roads, it is finally changed to the current location, please see Figure.3.

Figure. 4: *Environment of the site of Kaohsiung Big Egg*

This project is divided into 3 parts: “comprehensive stadium”, “affiliated facilities building” and “supporting organization building”. The comprehensive stadium is about 40m tall, the affiliated facilities building is a 5-story building with the height of 25m, the stadium and its facilities building takes up a total of 45,000 ping (about 148,500m²); the supporting organization building is a 10-story building with the height of 48m and the coverage of about 29,800 ping (about 98,340m²), and the total floorage is about 74,800 ping (about 246,840m²).

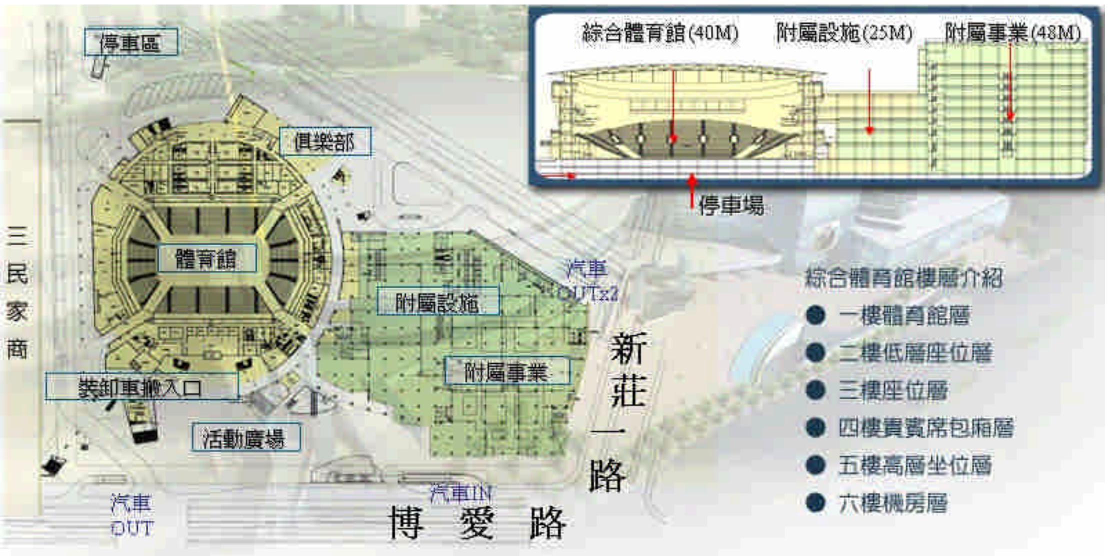

Figure 5: *Site Introduction of Kaohsiung Big Egg Development Project*

(2) Purpose and layout of the project:

At the beginning of development, this project is designed as a venue that constructed in accordance with the stipulations for "Green building" and the concept of sustainable design in consideration of the whole lifecycle of buildings to comprehensively show the following through the satisfaction and expectations of users: giving equal attention to the international trend of "sustainable landmark" and economic consideration of "unique attractions for visitors" as well as all aspects of commercial, cultural, sports and recreational so as to achieve diversified applications. Taking the main building, the comprehensive stadium, as an example, it utilizes the large roofing over the stadium to achieve recycling of rainwater and utilization of solar energy, etc. It utilizes natural ventilation, rainwater and solar generation panels to realize energy and carbon saving.

Upon the design of the layout, the project has passed indexes like indoor environment quality, sewage and trash reduction, waste reduction, etc. of the "9 indexes of Green Buildings in Taiwan". This project adopts the basic principles of reducing the cost, shortening the construction period, ensuring the changeability and structural safety to maximize the comfort of building and provide the building spaces with extensibility and changeability and has considered related measures ("centralized management", "decentralized control" and "labor saving") for future maintenance and management in the stage of design; As for creating local activity, a commercial facilities building is provided facing the open space, which is integrated with supporting organizations around the stadium, which improves its charm as a complex and provides the stadium with the potential opportunities to create flourishing vitality.

This study adopts this case to assess the operation outcomes of "the building performance of Kaohsiung Big Egg" in the opinion of CASBEE environment efficiency so as to propose the experience of cases in Taiwan in the international trend of sustainable building assessment.

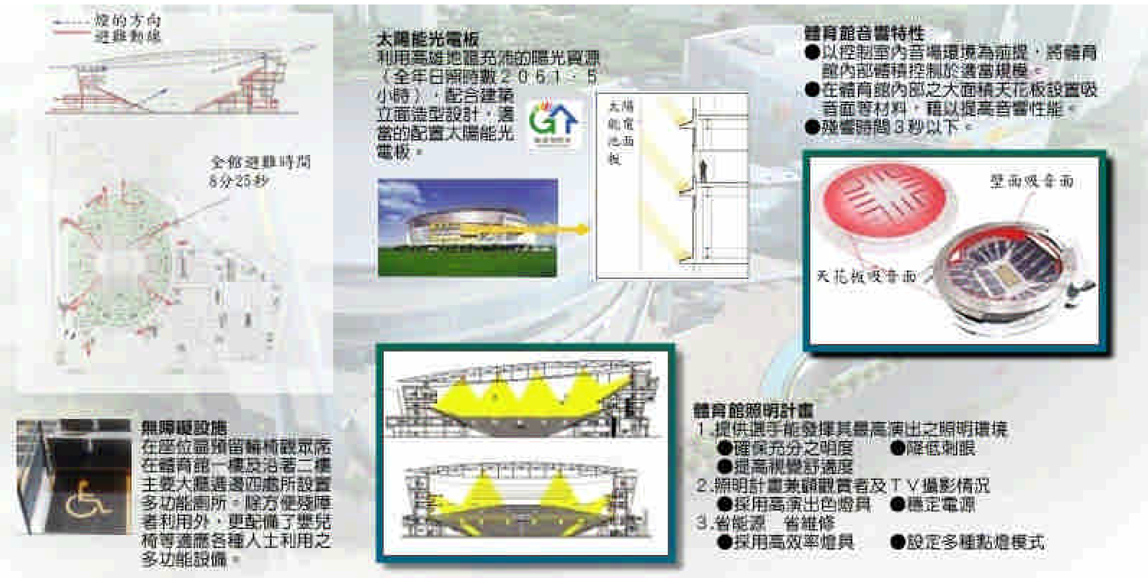

Figure. 6: *Green building design of Kaohsiung Big Egg*

4. Exploration of the Results of the Case Assessment

Kaohsiung Big Egg is located in the south of Taiwan, south of the tropic of cancer, the average temperature in this area if 25℃, and the relative humidity is over 75%.

(1) Scores of different CASBEE-NC assessment groups and items:

1. "Q: buildings environment quality and performance" :

In the assessment group of "Q-1 Indoor Environment", it scored 3.6; in the assessment group of "Q-2 Service Quality", it scored 3.7; in the assessment group of "Q-3 site internal and external environments", it scored 3.1.

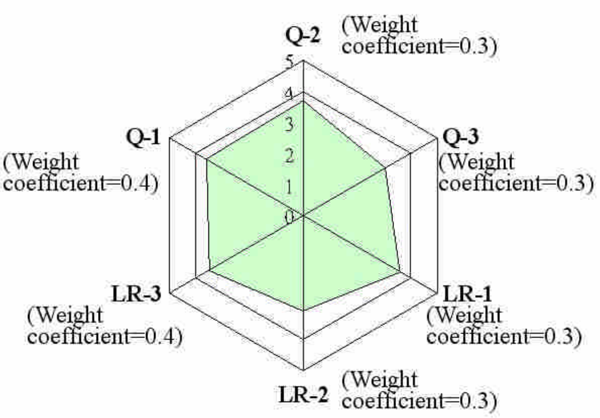

Figure 7. *Scores of different CASBEE-NC assessment groups*

Scores in different items of the assessment group of "Q-1 Indoor Environment": "sound environment" =3.0; "heat environment" =3; "light and visual environment"=2.7. Scores in different items of the assessment group of "Q-2 service performance": "functionality" =3.4; "durability and reliability =3.5; "correspondence and innovation" =4.3. Scores in different items of the assessment group of "Q-3 site internal and external environments": "diversity of bio-environment" =2.0; "considerations of urban landscape" =4.0, "considerations of regional facilities" =3.0.

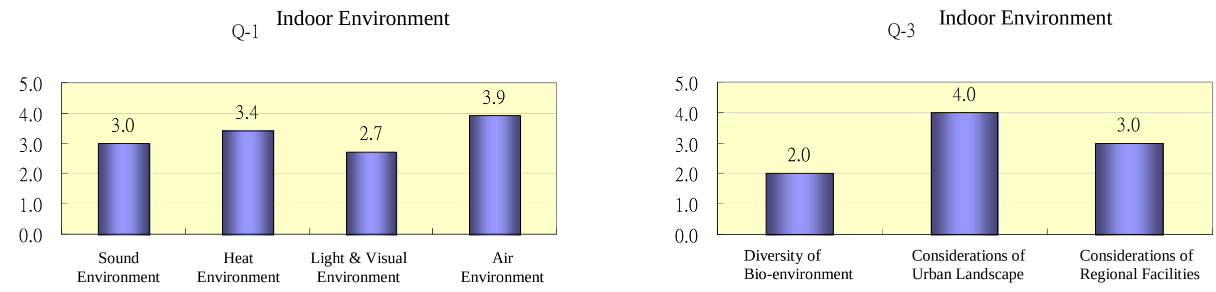

Figure 8*:. *Results of " buildings environment quality and performance"

2. "LR: reduction in environmental loads of buildings":

In the assessment group of "LR-1 energy", it scored 3.6; In the assessment group of "LR-2 resources and materials", it scored 3.1; In the assessment group of "LR-3 site external environment", it scored 3.5. Scores in different items of the assessment group of "LR-1 energy": "restraining of building heat loads" =4.0; "utilization of natural energies" =3.0; "efficient equipment and systems" =3.9; "utilization efficiency" =3.0. Scores in different items of the assessment group of "LR-2 resources and materials": "efficiency of water resources" =3.8; "materials with low environmental loads" =3.0. Scores in different items of the assessment group of "LR-3 site external environment": "prevention of air pollution" =3.0; "prevention of noise, shock and stench" =3.5; "prevention of wind hazard, sunshine obstacle" =3.0; "restraining of light hazard" =4.0; "improvement of deteriorated heat environment" =3.0; "reduction in loads of regional facilities" =5.0.

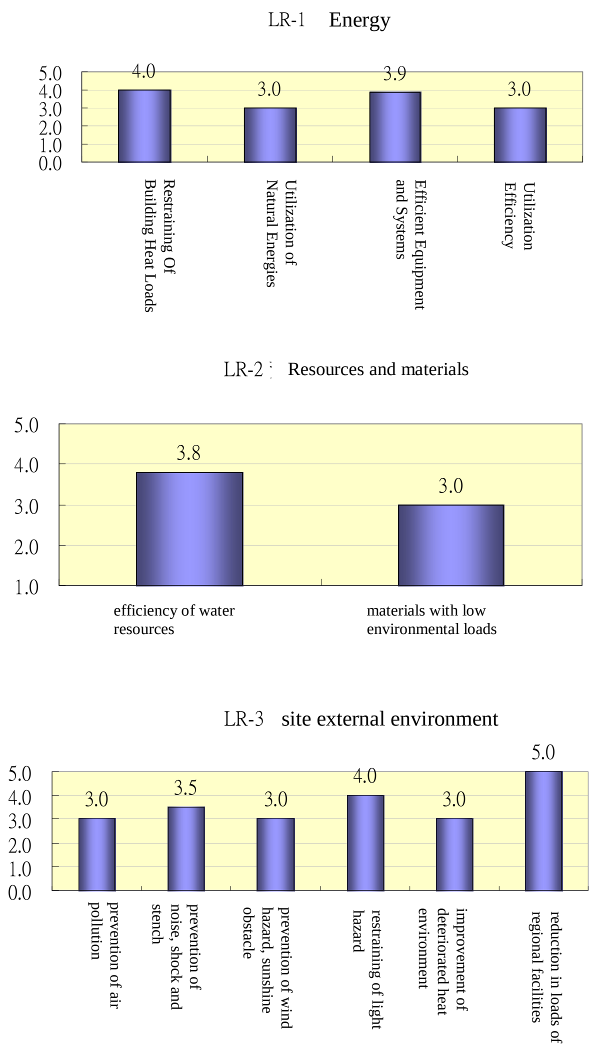

Figure 9*: *Results of "reduction in environmental loads of buildings"

(2) Disclosure of BEE assessment results:

There are 5 levels in the scoring system of CASBEE assessment, after inputting scores of assessment items, scores of different items and the total weighted scores of all items are calculated, thus the assessment results of Q and L are obtained, the distribution of scores may be shown in radar chart, the BEE result of the building environment assessment is obtained by dividing Q with L. Results of the CASBEE assessment are plotted in the chart according to the BEE values obtained, the scope of the assessment is within 0~5(>0). There are 5 ranks: S, A, B+, B- and C, should the score <0.5, it is ranked C (Poor); the score between 0.5~1 is ranked B- (Fairly Poor); the score between 1~1.5 is ranked B+ (Good); the score between 1.5~3 is ranked A (Very Good); the score >3 is ranked S (Excellent)4.

The score of the operation of the Kaohsiung Big Egg in this study with BEE is 1.6, which is in Zone A in the figure below, indicating the potential to be a sustainable building.

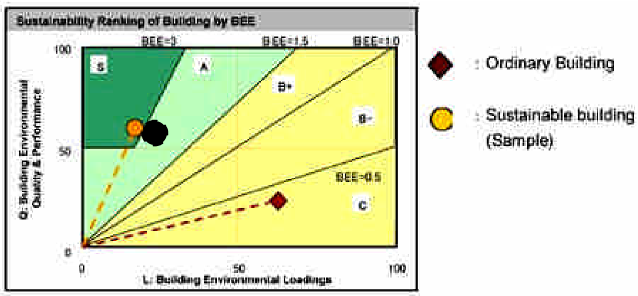

Figure 10: *Position of Kaohsiung Big Egg in the BEE assessment*

(3) Discussion on the operation results of the CASBEE-NC case:

Among all items in the assessment group of "Q: building environment quality and performance", item "correspondence and innovation" in "Q-2 service performance" scored the highest points, after reviewing its considerations in the stage of design, it is found that the designed height allows the change in different applications and the easiness for the piping according to updates of spaces. Items in the assessment group "LR: reduction in environmental loads of buildings" got the highest scores, "reduction in regional facilities" in "LR-3 site external environment" is ranked the highest, after reviewing its considerations in the stage of design, it is found that both infrastructures and future applications have been considered, guarantee of parking spaces in related events, for instance; as for the prediction for the impact of wind environment in the site, the defects have been improved in advance to provide fine indoor and outdoor spaces.

5. CONCLUSIONS

Through systematic sustainable building assessment tools, energy waste during the site development of buildings can be reduced, which not only protects the earth and reduces the consumption of resources, nut also controls the maintenance cost of buildings during the usage. Since Taiwan is located in the subtropics, it requires different environment technologies and standards from that of other countries in the temperate zone to cover all considerations of buildings during their whole lifecycle. This study assessed ad the Kaohsiung Modernized Comprehensive Stadium in Taiwan with the Japanese CASBEE assessment system, and the results have shown positive meanings.

[4] K. F. Chang, A Comparative Analysis of International Sustainable Building Assessment between GBTOOL and CASBEE，P.288，Architectural Institute of the Republic of China, the 16th Annual Architectural Research Thesis Collections, 2004

Reference:

1. CASBEE, the abbrieation of Comprehensive Assessment System for Building Environmental Efficiency, the famous evalution tool of Green Architecture advanced by IBEC Japan.

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3. IBEC，《CASBEE for New Construction Technical Manual》，2008

4. K. F. Chang, A Comparative Analysis of International Sustainable Building Assessment between GBTOOL and CASBEE，P.288，Architectural Institute of the Republic of China, the 16th Annual Architectural Research Thesis Collections, 2004

5. Shuzo Murakami, How to Design Advanced Sustainable Buildings, 2005.

Application of Green Building Ecological Index Group to Assess Ecological Quality of University Campuses

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Lin, Tie-Shyong[3]
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ABSTRACT

United Nations Agenda 21 pointed out that "Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues." Apparently, the correlation between education and environment is close. University is the heart of academia, therefore it has the major affect upon the environment. A eco-friendly university campus with good ecological quality, indeed encourages promoting environmental education and the idea of sustainability.

Taiwan in the past half-century, due to the population increase, the unban sprawl, and open space severely insufficient, these factors resulted in the poor ecological environment quality in Taiwan cities. If we can properly use the large open space in university campus as ecological nodes and stepping stone systems, it should contribute to promote the urban ecological environmental quality in Taiwan.

It is hoped that the method can be used as an evaluation tool to assess the ecological environment and as references for the designer to improve the environment of university campuses.

KEYWORDS

Green Building, Ecological Index Group, University Campus,
Ecological Quality, Sustainable Campus.

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1. INTRODUCTION

Recently, human activity seriously damages the natural environment we live in and expands to be global issues, such as greenhouse effect, acid rain, ozone layer destruction et al., which enforce the survive of living creature and human beings. In the wake of worsening environmental issues, therefore, people start to make announcement and find improvement for the future of environment, capital, and architecture.

Due to the convenience of field investigation and time limitation, the research objects are three Kaohsiung universities which are I-Shou University (ISU), National Kaoshiung University of Applied Sciences (NKUAS), National Kaoshiung First University of Sciences and Technology (NKFUST). It is hoped to develop an easy and efficient evaluation tool by ecological index group, and to access the ecological environment and as references for the designer to improve the environment of university campuses.

2. Green building ecological index group

There are three indicators of ecological index group which are indicators of biological diversity, indicators of greening, and indicators of raining storage in building site.

2.1 Indicators of biological diversity

The main purpose of biological diversity indicators is to consider the lower level creature of Ecological pyramid and develop diversified living spaces. In order to support the survival of high-level consumers, it must to ensure having a healthiness ecological environment of lower level (as the figure 1).

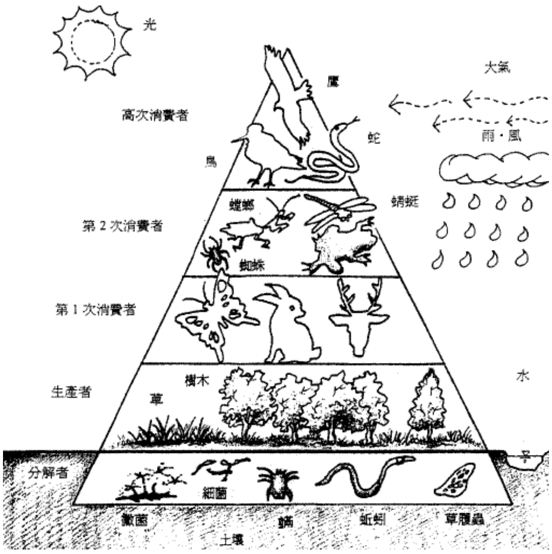

***Figure 1:** Ecological pyramid*

As if the Biodiversity indicators implemented to the base development, it would raise the quality of green and the attention of nature. To create more diversifier nature environment can support more diversifier creature, and make more possibility of living spaces for human beings.

And then to calculate each factors of will get the total scores of biological diversity indicators (BD). However, the total scores are necessary depended on different biological diversity conditions. Different area and different locations must have different standard.

2.2 Indicators of greenery

Plants are playing a very important role on maintain the ecological balance. Plants not only can relieve the feeling of tensions for human and beautify the view of environment, but also can reduce Carbon dioxide, modulate the micro-climate, and reduce noise of living place. Both greenery and biodiversity are the indicators of evaluated greening area. These two indicators have complementary function which greenery indicator presents “volume” and biodiversity indicators presents "quality". Nevertheless, biodiversity indicators only focus on more than 1 hectare bases but greenery indicators are suitable for any bases.

About evaluating greenery indicators, it is mainly to calculate the consumption of CO_2 in each area as a standard. The data is based on the size of tree and the square of leaves to calculate the consumptions of each tree. This indicator is included six items which are as following, ecological restoration layer greening area (m^2), tree volume and bush area (m^2), climbing plant area (m^2), and garden or grass area (m^2). After that, it can get the consumption of CO_2 (kg/m^2) in the certain base.

Meanwhile, the standard of CO_2 consumption is calculated by base area, building shelter rate (β), and minimum greening area (A'). The formula is $TCO2C = 1.5\times(0.5\times A'\times\beta)$. Once TCO2>TCO2C means passed the indicator.

2.3 Indicators of raining storage in building site

Plants The indicators of raining storage in building site mainly in view the soil and artificial soil whether it is up to conserve water and rain water storage capacity reserves. A base have better capabilities of raining storage and conservation, it will much benefit for micro-organism activities. Moreover, this indicator also can reduce the heat island effect which rising continuously, and reduce flood happen.

The indicator of raining storage in building site can be divided into two factors, which are common reserve water design and special reserve water design. Common reserve water design is focus on Greenland area, permeable pavement area and thickness, garden soil volume. On the other hand, special reserve water design is mainly calculating the volume of space and pool area, the volume of gravel, the length of infiltration of water pipes, the number of wells, and the length of ditch. To calculate all above factors will get total score of the indicator of raining storage in building site.

In this study, the formula is $\lambda = Qi/Q0$ which λ means the current situation index of this indicator, Q0 means undeveloped reserve storage, and Qi means developed reserve storage. The bigger of λ will have better reserve storage in a base. Moreover, λC means the standard index of this indicator. $\lambda C = 0.8\times(1.\tilde{0}r)$ which r means building shelter rate. As is $r > 0.85$, we set r are equal to 0.85.

3. Results

There According the statistic results and survey data, this study is hoped to gain a better understanding of ecological quality of the campus, and to be a reference of improvements. Finally, to develop an easy and efficient evaluation tool implement into rising university campus ecological quality.

3.1 The status of Indicators of biological diversity

The biological diversity indicators are mainly hoped to keep the largest habitats to support more diversified creature. This study is based on "Evaluation Manual for Green Buildings in Taiwan" and there are five evaluated factors. And it only ruled the base need more than 1 hectare to be evaluated. Therefore, all of these three universities are satisfied. Table 1 is the results of biological diversity indicator for these three ones.

Table 1. The results of biological diversity indicator for these three ones.

			ISU	KUAS	NKFUST
Indicators of biological diversity	Ecological environment	Total measure of green area	36	8	32
		Contact of the outside system	2	0	3
		Contact of the inside system	2	1	3
		Three-dimensional of plant	2	5	2
		Ecological corridor	0	0	0
	Ecological habitat	Natural revetment	0	0	8
		Ecological islet	0	0	0
		Stratified forest	6	2	5
		Bush and grass	2	3	4
		Ecological Slope wall	0	0	4
		Concentrate nature	0	0	3
	plant diversity design	Diversity index of tree	4.6	6	5
		Diversity index of bush	3	3	2.4
		Plant of native or attract bird and butterfly	1.6	2.1	2.9
		Stratified and hybrid plant	4	3.1	1
	Ecological soil	Surface soil reservations	0	0	3
		Organic Gardening	0	0	0
		Kitchen waste compost	0	0	0
		Defoliation compost	0	0	0
	Symbiotic equipment	Outdoor lighting effect	-5	-5	-5
		Lighting effect from outside	0	-5	-2
		Light reflection effect	0	0	0
	Total		58.2	23.2	71.3
	Standard value		75	55	60
	Result(Pass or not)		×	×	○

3.2 The status of Indicators of greenery

About evaluating greenery indicators, it is mainly to calculate the consumption of CO2 in each area as a standard and implement greening in base area. The total consumption of CO2 (TCO2) is 1.5 times than the standard of consumption of CO2 (TCO2c). This consumption of CO2 is calculating by the tree shadow area (Ai) as a reference value. Figure 2 is the results of greenery indicator for these three universities.

Table 2. The results of greenery indicator for these three ones.

		ISU	KUAS	NKFUST
Ecological restoration layer		55,686,000	3,356,400	44,070,000
Tree	Broad-leaved big tree	13,230,000	13,477,500	64,395,000
	Tree	10,575,000	4,170,000	20,730,000
	Palm	3,730,000	1,470,000	2,890,000
Buse		2,672,400	279,600	6,070,200
Climbing Plant		2,000	14,400	25,600
Garden and Grass		1,212,360	253,600	5,369,280
Old Tree	Broad-leaved tree	225,000	292,500	765,000
	Slender-leaved tree	150,000	315,000	1,020,000
Subtotal		87,482,760	23,629,000	145,335,080
Bonus(α)， $\alpha = 0.8 + 0.5 \times ra$		1.0	1.01	1.085
Total		87,482,760	23,865,290	157,688,562
Standard value		66,577,155	18,279,450	140,761,125
Result		○	○	○

3.3 The status of Indicators of raining storage in building site

The indicator of raining storage in building site can be divided into two factors, which are common reserve water design and special reserve water design. The former one is that reserve soil by capillary, and the later on is trying to rain on the base temporary. The results of this indicator are as following. (See Figure 3).

Table 3. The results of raining storage in building site indicator for these three ones.

		ISU	KUAS	NKFUST
Common design to reserve water	The values to reserve water on green	901	134	26,369
	The values to reserve water on permeable pavement	54	97	3,695
	The values to reserve water on grand	0	0	0

Special design to reserve water	The space to storage water to permeate	0	0	533
		0	0	1,853
Total		955	231	32,450
The values to reserve water when the base undeveloped		1,800	845	60,996
Calculated values (λ)		0.53	0.27	0.56
Standard value (λ_C)		0.5		
Result		○	×	○

3.4 The results of green building ecological index group for these three ones

This study compared these three universities by above three factors of ecological index group. And according to filed investigation and data analysis, the results of each indicator are as following. (Figure 4).

Table 4. The results of green building ecological index group for these three ones

	ISU	KUAS	NKFUST
Indicators of biological diversity	×	×	○
Indicators of Greening	○	○	○
Indicators of Raining Storage in Building Site	○	×	○

4. The simple assessment

According to Evaluation Manual for Green Buildings in Taiwan (2007), it is too complicate to evaluate each university campuses by current indicators of ecological index group. Hence, this study found a simple assessment by sectional indicators of the group to evaluate.

4.1 Screening the assessment factor

Based on Evaluation Manual for Green Buildings in Taiwan (2007) to asses campuses by ecological index group. To find there are some relevant in three indicators. Some factor can very conspicuous specific importance of indicator, have some factor use for little campus than difficult development inside campus too. Therefore, this study improves by EEWH enable to develop an easy and simple assessment to reflect campuses ecological quality.

First of all, figure 5 presents whether fit and adopt the original indicator in newly simple assessment or not.

Table 5. Presents whether fit and adopt the original indicators of biological diversity in newly simple assessment or not.

			Description	Result	Notation
Ecological network	Total measure of green area		Green area is a import index for ecological quality	○	
	Contact of the outside system		The contact to network with base	○	
	Contact of the inside system			○	
	Three-dimensional of plant		The effect is negligible in campus	×	
	Ecological corridor		There is not relevant in campus	×	
Microbiology habitat	Water	Natural revetment	There is not relevant in campus	×	
		Ecological islet		×	
	Grass	Stratified forest	To calculate green area and trees	×	
		Bush and grass		×	
	Micro-organism	Ecological Slope wall	There is not relevant in campus	×	
		Concentrate nature	Use a little space to develop	○	
	Other design			×	
Plant diversity design	Diversity index of tree		Significant improved for ecological quality	○	
	Diversity index of bush		Combine calculate with diversity index of tree	×	
	Plant of native or attract bird and butterfly		Plant of native or attract bird and butterfly	○	
	Stratified and hybrid plant		To calculate green area and diversity index	×	
Ecological soil	Surface soil reservations		There is not relevant in campus	×	
	Organic Gardening			×	
	Kitchen waste compost			×	
	Defoliation compost			×	
Symbiotic equipment	Outdoor lighting effect		This item is difficult to evaluate	×	
	Lighting effect from outside		This item is difficult to evaluate	×	
	Light reflection effect		There is not relevant in campus	×	

As the greening indicators, the data of bush quantity and green area et al. are relevant with tree diversity index and tree density index within biodiversity indicators. (See Figure 6 as following)

Table 6. Presents whether fit and adopt the original indicators of greenery in newly simple assessment or not.

		Description	Result	Notation
Ecological restoration layer		To calculate green area and diversity index of tree	○	
Tree	Broad-leaved big tree	To calculate green area and diversity index of tree	○	
	Tree		○	
	Palm		○	
Buse		Combine calculate with diversity index of tree	○	
Climbing Plant		The effect is negligible in campus	×	
Garden and Grass		Combine calculate with green area	○	
Old Tree		To calculate green area and diversity index of tree	○	
Bonus		Plant of native or attract bird and butterfly	○	

About raining shortage in building bite, the factor of greening area are calculated within biodiversity indicator and greening indicator. Only adopt the factor of water storage and permeation in the simple assessment as figure 7.

Table 7. Presents whether fit and adopt the original indicators of Raining Storage in Building Site in newly simple assessment or not.

		Description	Result	Notation
Common design to reserve water	The values to reserve water on green	Combine calculate with green area	○	
	The values to reserve water on permeable pavement	Combine calculate with the space to storage water to permeate	×	
	The values to reserve water on grand	The effect is negligible in campus	×	
Special design to reserve water	The space to storage water to permeate	There is the space to storage water to permeate in campus	○	
	The space under ground to storage water to permeate	This item is difficult to evaluate	×	

4.2 Build a simple assessment

After this research carries on the evaluation, this study develop a simple assessment by using seven main factors of ecological index group to evaluate campuses ecological quality. The newly-built assessment includes: total measure of green area, the contact to network with base, micro-organism habitat, diversity index of tree, density index of tree, plant of native or attract bird and butterfly, water storage and permeation in campus. (see Figure 8).

Table 8. The formula of simple assessment

	Assess item	Description	Score	Proportion
1	Total measure of green area Ax	Ax=green area/base area , Xi＝100.0×(Ax-0.15)		30
2	The contact to network with base	The contact to network with base		10
3	Micro-organism habitat	Ai=The area for Micro-organism Ai(m^2)×0.5		10
4	Diversity index of tree SDIt	Xt＝SDIt×0.8		15
5	Density index of tree (N/1ha)	W=tree volume / base area(ha) , Xw=10×(W/70)		15
6	Plant of native or attract bird and butterfly ra	Ra=The volume of native or attract bird and butterfly/all volume Xa＝ra×10		10
7	Water storage and permeation in campus.	Aw=The water area and the permeable pavement area / base area Xw＝Aa×10		10
	Total	Pass by 60		100

Direct against seven main factors according to simple assessment described above, the total points of each factor is based on original EEWH, the total score are set up by 100 points, and it is 60 points to pass standard. There are the explanations of each factor as following.

1. Total green area is the main factors of ecological index group within biodiversity indicator, greening indicator and raining storage indicator. Hence, the total score is set up to 30 which is highest weight.
2. The contact network with base factor means the contact level of internal and external network within base. Hence, the total score is set up to 10.
3. Micro-organism habitat is a factor of biodiversity factors which is mainly to create a porous and a diversity habitat. The total score is set up to 10.
4. The factor of tree diversity index is not only for biodiversity indicators mainly, but also for greening indicators as reference. The total score is set up to 15.
5. Density index of tree, this study joined this factor after assessment via practical operation. This factor not only presents ecological quality efficiently of biodiversity indicator, but investigates the consumption of CO_2 in base site. Hence, the total score is set up to 15.
6. About plant of native or attract bird and butterfly factor, it is used by biodiversity indicator and greening indicator. Mainly in order to encourage adopting and giving birth to or luring birds and luring the butterfly plant in the base originally more, reduce

outside kinds of quantity, and increase birds or butterfly types. The total score is set up to 10.

7. The factor of water storage and permeation in campus which is mainly focus on raining storage in the building site, in order to evaluate permeable pavement and ecological water area within the base. The total score is set up to 10.

Table 9. Summarizes the statistic for each factor of newly-build assessment.

	Assess item	Description	Score
1	Total measure of green area Ax	Ax=green area/base area , Xi＝100.0×(Ax-0.15)	30
2	The contact to network with base	The contact to network with base	10
3	Micro-organism habitat	Ai=The area for Micro-organism $Ai(m^2)×0.5$	10
4	Diversity index of tree SDIt	Xt＝SDIt×0.8	15
5	Density index of tree (N/1ha)	W=tree volume / base area(ha) , Xw=10×(W/70)	15
6	Plant of native or attract bird and butterfly ra	Ra=The volume of native or attract bird and butterfly/all volume Xa＝ra×10	10
7	Water storage and permeation in campus.	Aw=The water area and the permeable pavement area / base area Xw＝Aa×10	10
	Total	Pass by 60	100

4.3 The application of simple assessment

Based on the above seven factors as reference to evaluate the three subjects, Figure 10, Figure 11 and Figure 12 illustrates the differences of these three factors implement to evaluate ecological quality.

Table 10. **A**pplication of simple assessment to assess Ecological Quality of ISU

	Assess item	Description	Score
1	Total measure of green area	Xi＝100.0×(Ax-0.15)	30
2	The contact to network with base	The contact to network with base	5
3	Micro-organism habitat	$Ai(m^2)×0.5$	0
4	Diversity index of tree	Xt＝SDIt×0.8	8
5	Density index of tree	Xw=10×(W/70)	11.3
6	Plant of native or attract bird and butterfly	Xa＝ra×10	3.2
7	Water storage and permeation in campus	Xw＝Aa×10	2.6
	Total	Pass by 60	60.1

Table 11. Application of simple assessment to assess Ecological Quality of KAUS

	Assess item	Description	Score
1	Total measure of green area	Xi＝100.0×(Ax-0.15)	8
2	The contact to network with base	The contact to network with base	2
3	Micro-organism habitat	Ai(m^2)×0.5	0
4	Diversity index of tree	Xt＝SDIt×0.8	12
5	Density index of tree	Xw=10×(W/70)	14.8
6	Plant of native or attract bird and butterfly	Xa＝ra×10	4.2
7	Water storage and permeation in campus	Xw＝Aax10	3.4
	Total	Pass by 60	44.4

Table 12. Application of simple assessment to assess Ecological Quality of NKFUST

	Assess item	Description	Score
1	Total measure of green area	Xi＝100.0×(Ax-0.15)	30
2	The contact to network with base	The contact to network with base	8
3	Micro-organism habitat	Ai(m^2)×0.5	6
4	Diversity index of tree	Xt＝SDIt×0.8	10
5	Density index of tree	Xw=10×(W/70)	9.1
6	Plant of native or attract bird and butterfly	Xa＝ra×10	6
7	Water storage and permeation in campus	Xw＝Aax10	6.1
	Total	Pass by 60	75.2

According to the above figures, NKFUST has highest ecological quality, next is ISU. However, KUAS does not pass by this assessment. And this study found that the results of simple assessment have no differences form the EEWH. Moreover, the simple assessment also illustrates ecological quality of each university campuses. To compare the originally index with newly build index, the results are as following.

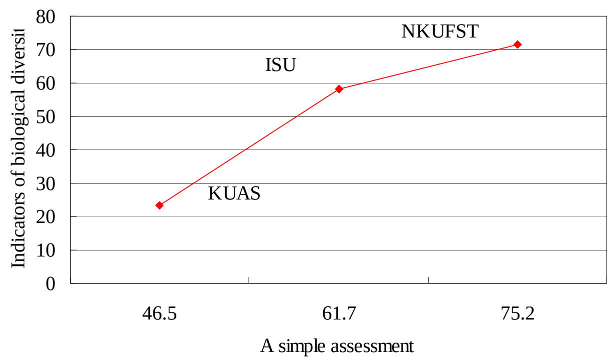

Figure 2: The correlation results of simple assessment and Indicators of biological diversity

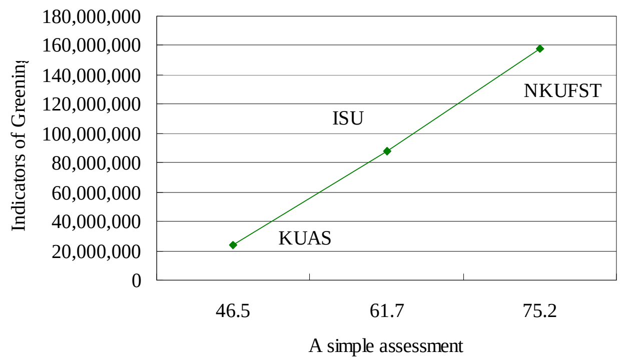

Figure 3: The correlation results of simple assessment and Indicators of Greening

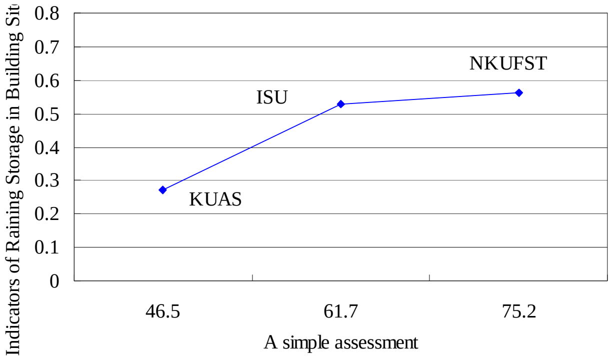

Figure 4: *The correlation results of simple assessment and Indicators of Raining Storage in Building Site*

The correlation results reported in these three figures suggests that the simple assessment are positive correlated with originally ecological index group. Therefore, the newly build assessment can illustrate campuses ecological quality efficiently.

5. Conclusion

This study develops a new and simple assessment to evaluate campuses ecological quality because the original evaluation of EEWH is too complicate and some factors are too relevant. The new assessment are only seven evaluated factors includes: 1.Total measure of green area、2.The contact to network with base、3.Micro-organism habitat、4.Diversity index of tree、5. Density index of tree、6.Plant of native or attract bird and butterfly、7. Water storage and permeation in campus. And from the investigation and statistic analysis, the simple assessment can illustrate efficiently ecological quality of university campuses.

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Taiwan Green Building Material Labeling System and its comparison with international labeling systems

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ABSTRACT

The serious energy and natural resource shortaage that our living environment is currently facing shows a strong demand to develop a better building material certification and management mechanism. Following a ten-year green building material evaluation and labelling research program which started around 1998, the Architecture and Building Research Institute (ABRI) of Taiwan proposed the Green Building Material (GBM) Labeling system in 2003 and was officially launched in 2004. The GBM system aims to promote a sustainable built environment for the Earth and a healthier living quality for human beings. It was established based on the ISO15686 series, ISO21930 series, ISO14040 series, as well as the Integrated Building Performance (IBP) system proposed by the EU to ensure that the evaluation criteria and standards meet the current development trends of the world. The Taiwan GBM evaluation system incorporates low toxicity, minimal emissions, low-VOC during assembly, recycled content, resource efficiency, recyclable and reusable materials, energy efficiency, water conservation, IAQ improvement, and use of locally products, among others (Froeschle, 1999). The criteria is systematically comprised of four categories, including health, ecology, high-performance and recycling. The assessment mainly adopts the life cycle assessment approach, covering four stages of the life cycle of a building: resource exploitation, production, usage, and disposal and recycling.

This paper shows the comparison between Taiwan GBM Labeling System and other international labeling systems namely GREENGUARD, BLUE ANGEL and GOODENVIRONMENTAL CHOICE in terms of program verification procedures and evaluations. The issues of indoor air quality (IAQ) (Wolkoff 1998), indoor environment quality (IEQ), and indoor environment health (IEH) have also been addressed to look further into the connection among the different labelling systems.

KEYWORDS

Green Building Material, Life Cycle Assessment, indoor environment quality (IEQ)

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1. INTRODUCTION

Entering into the 21st century, due to emerging abnormal environmental changes and severe use of energy, the whole world is rigorously devoted to finding a way to respond to issues such as energy saving, coal use reduction, and health. In Taiwan, promotion of green Building and Green Building Material (GBM) has gained considerable attention as well. Along with the international main trends, the domestic policy of Sustainable Development is now guiding Taiwan's land development toward the direction of eco-cities with green building on the basis of human health, earth sustainability, and industry development to pursue the practical efficacy of sustainable environment. Green Building Material (GBM) is the key factor contributing to green building, healthy building, and the response to international trend of sustainability, which has undertaken the critical stand in the entire sustainable construction framework.

Following the promotion of green building evaluation and labeling more than a decade, the Architecture and Building Research Institute (ABRI) of Taiwan proposed the Green Building Material (GBM) Labeling system in 2003 and was officially launched in 2004, shown in Fig. 1. The system is aimed to promote a sustainable built environment for the earth and a healthier living quality for human beings. It was established based on ISO15686 series, ISO21930 series, ISO14040 series, as well as the Integrated Building Performance (IBP) system proposed by the EU, to ensure the evaluation criteria and standards meeting the current development trend of the world. Both global and local environmental issues, such as anticipated exhaustion of fossil fuels, increasing and fluctuating energy prices (Meadows et al., 2006), environmental pollution problems, high dependency on imported resources, high temperature and high humidity, a large amount of CO_2 emission from the building industry, as well as over 10 million-ton construction wastes generated annually, must be taken into consideration to develop a comprehensive assessment tool for green building materials.

In general, the assessment of green building materials begins with establishing criteria for evaluating the environmental performance of building materials. The criteria may incorporate low toxicity, minimal emissions, low-VOC assembly, recycled content, resource efficiency, recyclable and reusable materials, energy efficiency, water conservation, IAQ improvement, locally products, etc (Froeschle, 1999).

Figure 1 *:Taiwan green building material label*

With extensive material usage of indoor decoration and remodeling for housing, formaldehyde (HCHO) in building materials and volatile organic compounds(VOCs) emitted in a warm environment can result in fairly high amounts risky or harmful to health (Shao et al,2003). According to relevant research results (Wu et al., 2003), the risk values of carcinogens such as the formaldehyde in building materials and VOCs in office spaces in Taiwan are 100 to 1,000 times fold over the WHO standard, causing people to suffer from respiratory and skin diseases. The GBM system can contribute to a healthier indoor environmental quality. The issues of indoor air quality (IAQ) (Wolkoff 1998), indoor environmental quality (IEQ), and indoor environmental health (IEH) have been addressed and being further studied. From the perspective of the "Architecture Doctor (AD)" concept, now researchers and experts would diagnose causes of IEQ problems and prescribe recipes, for instance, strategies of green building and green building material application.

2. EVALUATION SYSTEM ,IMPLEMENTATION AND MANAGEMENT

The major purpose of the GBM labeling system can be described in three parts: 1) promotion of high-quality and healthy life; 2) protection of ecological environment; and 3) enhancement of industry competition ability. The system focuses on the entire building quality and effective management and control of human health risk factors. Its general requirement includes basic environmental protection aspects, such as no asbestos, no heavy metal, no radioactivity, etc. The evaluation system consists of four categories of the life cycle of a building (resource exploitation, production, usage, disposal and recycling) is illustrated as Fig. 2.

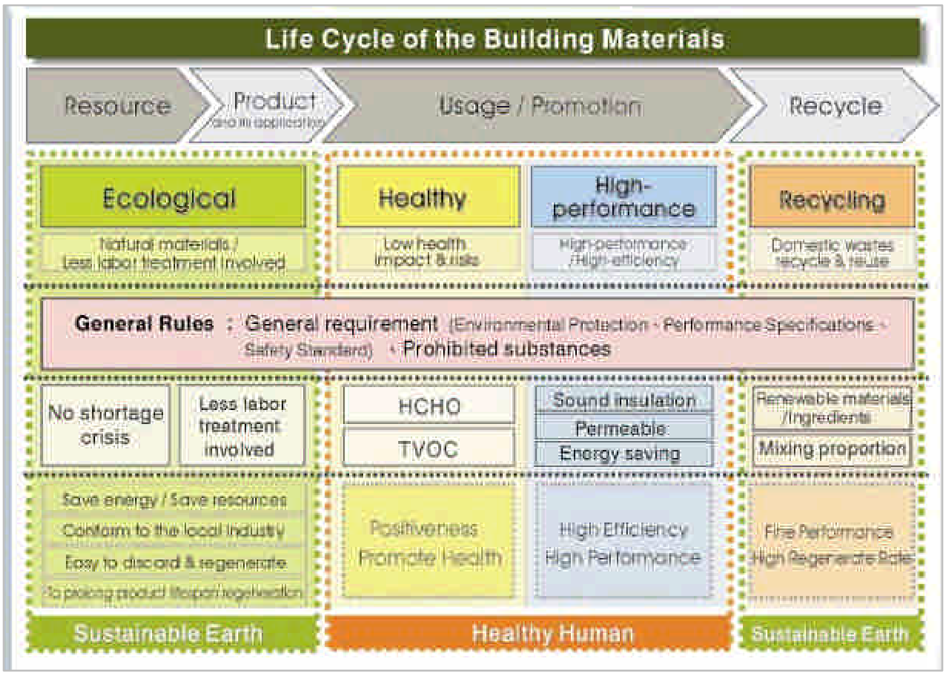

Figure 2 *:Framework of Taiwan green building material evaluation system*

The Taiwan GBM system is classified into four categories: Ecological, Healthy, High-performance and Recycling. Each of their standards and criteria accommodating subtropical climatic characteristics of high temperature and high humidity are also specified.

a) Ecological GBM: What is taken from nature shall be returned to nature. The building material fulfills general requirements, uses natural materials of which there is no shortage, consumes minimal resources and energy, requires less labor treatment, or possesses recycled characteristics after disposal.

b) Healthy GBM: The system focuses on the management and control of the relevant hazards, and reduce formaldehyde (HCHO) and TVOC that are added during the production of interior decoration materials, such as coding and glue preparation etc.

c) High-performance GBM: The materials and units are supposed to pass a high performance test. In order that they will be identified as high quality, they must be able to increase total efficiency without the flaws existing in conventional building materials. At present this GBM includes sound insulation, permeable paving and energy saving glass.

d) Recycling GBM: In order to reduce construction waste, and to reuse and recycle materials and achieve sustainability, the system focuses on the reuse of green building materials and improve the reuse rate of waste materials, but ensure basic functional demand.

For the practical operation of the GBM labeling system, the testing departments are national standard laboratories passing TAF accreditation. The factory owners of building materials can file the application and supply test data with TAF certification, proofs of production, ingredient and quality control, and registration document of its legality. Through the review by the Green Building Material Labeling Review Committee, suggestions of approval or rejection are given. For those who pass and obtain the green building material label conferred by the Architecture and Building Research Institute, the label is valid for 2 years and is renewable. In terms of post-market management mechanism of green building material labeling, non-scheduled spot checks are implemented to ensure the use of the GBM label and the quality of green building materials.

3. EVALUATION RESULTS AND MARKET TREND ANALYSIS

By the end of March of this year, 199 GBM Labels have been conferred covering 1,631 green products. Among these products, the healthy material occupies 77.9%, and followed by the high-performance category14.1%, recycling 7.5%, and ecological 0.5%, shown in Fig. 3. The percentage distribution indicates the health issue has been highly emphasized and points out the development trend of the building material market in Taiwan. For a non-toxic and healthy architectural environment, as well as sound-proof and permeable function of building materials, there are 1,631 green building material products, including 592 building decoration paints, 94 wooden floors, 138 wooden boards, 103 gypsum wallboards, 161 inorganic boards, 52 organic boards, 1 rug, 5 glue preparations, 1 crack fillings, 11 soundproof door, window and wall systems, 3 floor coverings, 28 high pressure concrete ground bricks, 8 absorbent material systems, 156 permeable bricks, 73 ceramic face bricks, 3 energy saving glass, 3 aggregates and 199 PVC products. Mostly, paints ranked the highest, followed by permeable bricks, as well as wooden boards and gypsum wallboards.

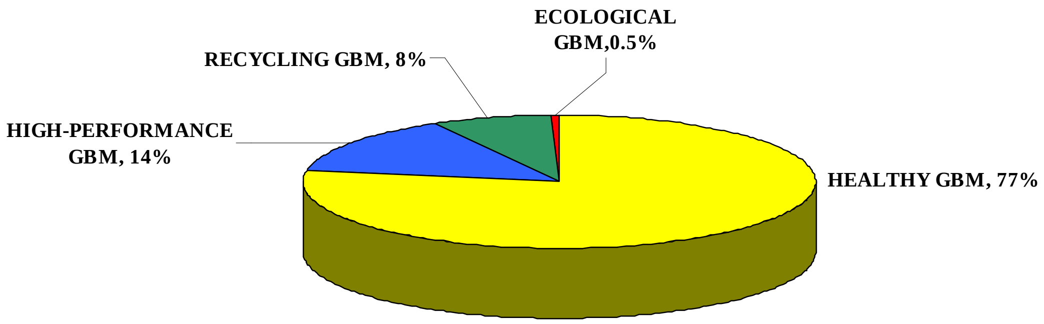

***Figure 3**: Percentage of four categories of GBM labeling promotion*

4. COMPARISON WITH INTERNATIONAL LABEL SYSTEMS

Under trade liberalization by the WTO, countries have reduced tariffs on imported goods to seek fair competence. The reduction is particularly obvious in developing countries. To maintain industry level and markets, a lot of developed countries have introduced non-tariff countermeasures, so-called *technical trade barriers*, to protect domestic industries. Such barriers include *quality standards, technology standards,* or *certification of logos* to maintain and protect domestic industry and market. Taiwan entered the WTO on 1 January 2002. It has been 7 years since and this has a big impact on the domestic construction industry. A lot of poor quality low price building materials were imported into Taiwan, leading to price competition and inferior quality. The Architecture and Building Research Institute, Ministry of Interior established a major mechanism—green building material certification system to distinguish the good from bad. The mechanism is successful in the construction industry in Taiwan and is gradually improving construction quality.

Over 90% of the building materials industry used to focus on the domestic market. To turn to export, they are encouraged to work under green building certification to enhance their technology to the international level. Export expansion programs by the Ministry of Economic Affairs and the Ministry of Foreign Affairs will help the transformation of factories and plants to open up to the export market and increase the market capability of the industry.

In January 2008, the Ministry of Interior promoted the Ecology City Green Building Promotion Project to cover green building materials in international exchange. Point 7 of the implementation guiding principles specifies: to continually promote green building material certification, enhance green building material certification international exchange and evaluation to achieve the international level.

Currently, contacts have been made with GREENGUARD in the U.S., GOOD ENVIRONMENTAL CHOICE in Australia, ECOLOGO in Canada and DER BLAUE ENGEL in Germany to offer green building material certification information in Taiwan. Suggestions on mutual cooperation agreement have been made. ECOLOGO in Canada and DER BLAUE ENGEL in Germany are not willing to have mutual certification. GREENGUARD inquired about technical questions on green building materials evaluation and testing in Taiwan, including product test time limits, test standards, test cabin operation conditions, air exchange efficiency, material sealing, VOCs and HCHO chemical analysis methods, sampling timing, evaluation criteria (emission efficiency), test report validity and accrediting units.

GREENGUARD certificate control covers office furniture and equipment, wall covering materials, ceilings, coatings, floors, heat and sound insulation materials, other building materials, textile products, consumer products, and cleaning products. Based on product property, certification is made on formaldehyde, VOCs, ozone, CO, NOx, CO_2, and respirable dust. Emission tests are per ASTM D 5116-97 and D 6670-01 and EPA methods. In the $32m^3$ cabin volume, testing is done for 5 days under 0.8 ACH under the conditions shown in Table 1:

Table 1. GREENGUARD Certification Emission Test Method

Governing standards	Temperature	Moisture	Air exchange rate	Load rate	methods
GREENGUARD Certification Standards for Low Emission Products for Indoor Environments	23℃±2℃	50%±5%	Min. $0.8 \pm 0.025 h^{-1}$	0.4 m^2/m^3	ASTM 5116-97 6670-01 US.EPA

Comparing with Taiwan, the methods are similar and have similar conditions in temperature, humidity (25%, 50%) and load rate (0.4 m^2/m^3). The difference is the air exchange rate (0.5 in Taiwan and 0.8 in the U.S.). Test time is 5 days in the U.S. and 48 hours (steady state) in Taiwan or achieved evaluation standard value.

GOOD ENVIRONMENTAL CHOICE is the Australian first category declaration environment label system. This is more similar to environmental protection label system in Taiwan. On the other hand, the GBM Label system is in the third category declaration. The building material life cycle as evaluation criteria conforms to the international environment level. Evaluation covers floor materials, coatings, ceilings, and heat insulation materials, etc, especially regarding health concern, VOCs, formaldehyde, physical factors, chemical factors and biological factors. Australian test methods are similar to ISO standards, although VOCs leaching content value differs from test cabin emission sampling in Taiwan.

5. CONCLUSION

Since July 2006, the mandatory green building material utilization has been included in Taiwan's building code. For indoor decoration and floor materials in buildings, green building materials shall cover at least 5% of the total indoor decoration and floor material uses. Fulfilling the requirements of ecological, recycling, healthy, and high-performance attributes, the green building material regulation may effectively reduce environmental impact and improve IEQ, so as to gradually achieve "human health and global sustainability." Starting from energy saving and resource efficiency by combining an ecological circulatory system, corresponding local environment, community civilization, as well as historic and regional features, the GBM system creates a core concept of sustainable built environment in Taiwan.

Meanwhile, local scholars and specialists' comments on technical differences shall be organized to evaluate modification of technical systems and to seek ways to achieve the international level. Future work will continue building a connection between Taiwan Green Building Material Labeling system and international labeling and evaluation system, striving to develop an international certification mechanism, building collaboration mechanism and interchange with countries that also work on sustainable development, and further promoting the application of Taiwan's GBM and green technology worldwide.

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Environmental Efficiency of Functionality for Residential Buildings in Taiwan

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ABSTRACT

Under the conditions of global environmental problems and the rapid change of society, many existing buildings have not support the user' needs in the aspects of sustainability and functionality, especially for residential buildings. Moreover, little attention has been devoted to the functionality of a building in "Green Building Labeling System" of Taiwan. This purpose of this study was to propose an indicator, environmental efficiency for functionality, for assessing the environmental efficiency of functionality for residential buildings in Taiwan.

Two indices, quality of functionality and building environmental loadings, composed the environmental efficiency of functionality. Environmental efficiency of functionality, based on the concept of the building environmental efficiency in Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), was defined as the quality of functionality divided by the building environmental loadings. Fuzzy Delphi Method and Fuzzy Analytic Hierarchy Process were applied to confirm the suitability and to investigate the priority of components in the assessment hierarchies for two indices by expert questionnaires.

Two hierarchies were established for assessing the environmental efficiency of functionality for residential buildings. Moreover, the experts' opinions showed that "functional ability" and "energy" was the critical issue in the quality of functionality and building environmental loadings for residential buildings, respectively. The indicator presented in this paper may be used to evaluate the environmental efficiency of functionality for residential buildings. Moreover, the degree of improvement for functionality might be evaluated by the increased environmental efficiency of functionality in renovation stage for a residential building.

KEYWORDS

Building environmental efficiency, Environmental assessment, Environmental loading

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1. INTRODUCTION

With the extensive concerns for global environmental problems, sustainability has received considerable attention for building planning and management. Building environmental assessment methods were developed to evaluate the performance of buildings across a broad range of environmental considerations in different countries. Cole (1999) suggested that the roles for building environmental assessment methods in development and application are to deliver objective measurements of a building's impact on environment, as well as to extend the communication and interaction between design team and various sectors with the building industry. Explicit and comprehensive building environmental assessment methods have become extremely critical.

Over the past few decades, society has undergone a rapid change and emerged some special issues, such as population aging, declining birth rate, and technological life. For existing residential buildings, the fundamental designs have not been sufficed for users' needs in nowadays. Functionality for residential buildings refers the suitability for the dwellings. It is very important to the basic essentials for sustainable buildings, especially for living quality and building longevity.

Eco-efficiency is defined by the World Business Council for Sustainable Development (WBSCD) as per unit of service causes minimal restraints on the environment. It is calculated by the service value divided by the impact on the environment. Environmental efficiency, bases on the concept of eco-efficiency, has been proved to be an appropriate indicator for addressing environmental impacts in a comprehensive way (Assefa, et al., 2007; Endo, Murakami, and Ikaga, 2008; Malmqvist and Glaumann, 2009). Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) in Japan is the first attempt in the world to apply the concept of eco-efficiency in environmental assessment method and is designed for the assessment of buildings during the whole lifecycle. It is based on a concept that clearly distinguishes the quality of building performance (Q) and the environmental loading (L). An indicator, Building Environmental Efficiency (BEE), was developed to evaluate the environmental efficiency of buildings. BEE is defined as building environmental quality (Q) divided by building environmental loadings (L). The higher BEE value represents the higher environmental performance of a building (Endo, Murakami, and Ikaga, 2008; JSBC, 2006).

In Taiwan, "Green Building Labeling System" was established to promote the considerations for resource depletion, energy usage and waste generation during the life cycle of buildings. There are nine indicators in this system (Lin, 2003). Compare to other widely known building assessment methods, such as SBTool (formerly known as GBTool) and CASBEE, little attention has been paid to the functionality of buildings in "Green Building Labeling System". Functionality is an important element for promoting building performance and living quality. Chang (2007a) recommended that functionality could be an additional indicator for building environmental assessment method in Taiwan. Therefore, the purpose of this study was to establish an indicator which can evaluate the environmental efficiency of functionality for residential buildings in Taiwan, following the concept of BEE in CASBEE.

2. METHODS

Two indices, quality of functionality and building environmental loadings, were developed to evaluate the environmental efficiency of functionality for residential buildings in Taiwan. A hierarchical structure was established for each index, based on the assessment framework of quality of service and building environmental loadings in CASBEE. Then the Fuzzy Delphi Method (FDM) was applied to confirm the suitability of these two assessment hierarchies. Finally, the Fuzzy Analytic Hierarchy Process (FAHP) was used to determine the weights of components for these two assessment hierarchies.

2.1 The Fuzzy Delphi Method (FDM)

The Delphi Method is a method to obtain quantified opinions from a number of experts in a specific field. Some studies proposed the repetition of surveys to converge experts' opinions and the possibility of filter out particular experts' opinions are the weaknesses of the Delphi Method. Therefore, the Fuzzy Delphi Method (FDM) which integrates the Delphi Method and the fuzzy theory is developed to solve the questions about fuzziness and repetitive surveys of the Delphi method (Kuo and Chen, 2008).

Hsu, Wey and Tsai (2007) applied the triangular fuzzy number to encompass experts' opinions. The triangular fuzzy number of the minimum acceptable value (Min^i) for a component was composed of the least value (Min^i_L), geometric mean (Min^i_M) and ultimate value (Min^i_U) from all minimum acceptable values for a component by the experts. Similarly, the triangular fuzzy number of the maximum acceptable value (Max^i) for a component was composed of the least value (Max^i_L), geometric mean (Max^i_M) and ultimate value (Max^i_U) from all maximum acceptable values for the same component. The value of consensus from experts was convergent and calculated in two conditions, either two triangular fuzzy numbers was no overlap (Figure 1 a) or the overlap not exceeding the range of two geometric means Min^i_M and Max^i_M (Figure 1 b).

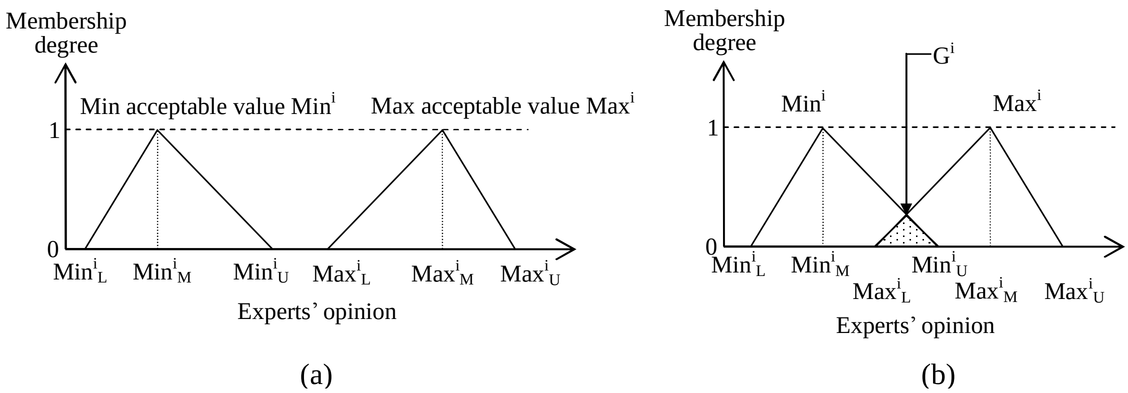


***Figure 1:** Triangular Fuzzy Number of Minimum and Maximum Acceptable Value*

In this study, a 0-10 point scale with extremely unimportant at the low end and extremely important at the high end was utilized. The suitability of criteria in the assessment hierarchies were decided by the mentioned above. After the values of consensus were calculated, a threshold value was decided according to the threshold value in corresponding studies adopted the same 0-10 point scale (Hsu, Wey and Tsai, 2007). "6" was set to be the threshold value in this study.

2.2 The Fuzzy Analytic Hierarchy Process (FAHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making method to represent a problem hierarchically by a systematic process (Chang, Chiang, and Chou, 2007b). The fuzzy Analytic Hierarchy Process (FAHP) is an advanced analytical method to determine the appropriate weight for each component in a hierarchy, which can improve the uncertainty and imprecise ranking a number to the judgment of one person in AHP. Experts were asked to compare a component at a pairwise basis in order to estimate the relative importance to other components in the hierarchy. A triangle fuzzy number, scores from 1 to 9, was used to present the evaluation from equal to extremely importance. It was composed of the minimum acceptable value, the most likely value and the maximum acceptable value (Kwong and Bai, 2003; Pan, 2008).

The opinions of each expert were tested initially by the consistency index and consistency ratio. These indices were used to measure any inconsistency within the judgments in each comparison as well as for the entire hierarchy. The expert questionnaire was exclusive if the consistency ratio was less than 0.1 (Kwong and Bai, 2003). Besides, a similarity aggregation method (SAM) was used to combine the fuzzy opinions of experts and to evaluate the weights of components in two hierarchies in this study (Hsu and Chen, 1996; Wang and Tseng, 2003).

3. RESULTS AND DISCUSSION

The concept of eco-efficiency has been widely applied to assess building environmental efficiency in Japan and Sweden. The BEE value is evaluated by two indices the quality of building performance (Q) and the environmental loading (L) which are combined to assess the environmental performance of a building in CASBEE (Endo, Murakami, and Ikaga, 2008). Moreover, Malmqvist & Glaumann (2009) presented a similar approach to assess user satisfaction related to the indoor environment and the environmental impact related to the energy use of a building. Two indices were developed, one index related to perceived quality by the users which corresponded to the Q index while one index reflecting the external environmental impact which corresponded to the L index in the CASBEE. The applications of these two indices to assess building environmental efficiency have been widely demonstrated. Based on the concept of CASBEE, quality of functionality and building environmental loadings were developed to assess the environmental efficiency of functionality for residential buildings in this study.

3.1 Developing the Assessment Hierarchies

First, two assessment hierarchies for quality of functionality and building environmental loadings for residential buildings were established based on the assessment hierarchies in CASBEE. In addition, the suitability of each assessment hierarchy was evaluated by FDM. Figure 2 and Figure 3 show the assessment hierarchy of quality of functionality and building environmental loadings for residential buildings which had modified by the experts' opinions. The detail for developing and evaluating the assessment hierarchies were described below.

Quality of functionality for residential buildings included the quality of functionality in the building environment as well as the considerations of environmental quality of the outdoor environment on site and its surroundings. In CASBEE, building environmental quality Q is an aggregated index of three main issues. Quality of service and outdoor environment are two of the three issues. Service ability, durability and reliability, flexibility and adaptability are the criteria for quality of service (JSBC, 2005). As shown in Figure 2, four categories: functional ability, durability and reliability, flexibility and adaptability, outdoor environment are included in the assessment hierarchy for quality of functionality in this study. In CASBEE, the value of environmental loadings L is derived from the evaluation of the reduction of building environmental loadings (LR). The assessment hierarchy for LR composes of three categories: energy consumption, resources consumption and off-site environment. Off-site environment concerns to the reduction of the impacts on the environment beyond site boundaries (JSBC, 2005). The assessment hierarchy for building environmental loadings was composed of the same three categories in this study. Considered to the systematization of hierarchy, independence of criterion, and feasibility of evaluation, the criteria and the sub-criteria for each category in these two assessment hierarchies were developed based on the assessment hierarchies in CASBEE.

Moreover, the suitability of each assessment hierarchy was evaluated by FDM. A survey was conducted to collect experts' opinions about the importance of each component in two assessment hierarchies. Experts were asked to express their opinions of the importance for each component by giving three values: the minimum acceptable value, the most likely value and the maximum acceptable value by a 0-10 point scale. A total of twelve expert questionnaires were collected, inclusive of five architects, three officials and four scholars in related field of architecture. The values of consensus were calculated by the procedures mentioned before.

For the assessment hierarchy for quality of functionality, the results showed that the values of consensus for all criteria (Level 2) were higher than the threshold value, 6. These results suggest that experts confirm the suitability for these nine criteria in this assessment hierarchy. Besides, the values of consensus for 21 sub-criteria (Level 3) in the assessment hierarchy were calculated and the results showed that the values of consensus for "comprehensive decoration planning" (5.70) in "A2 Amenity" and "flexibility in floor height" (5.57) in "C1 Flexibility" were lower than the threshold value, 6. These data reveal that these two sub-criteria may not be the important components in the evaluation of the quality of functionality for residential buildings by the experts' opinions. Figure 2 shows the assessment hierarchy for quality of functionality by integrating the experts' opinions. As can be seen from the figure, this assessment hierarchy is composed of four categories, nine criteria and 19 sub-criteria. Three criteria of the category "D Outdoor environment" and 19 sub-criteria of other three categories are designed to be the assessment items for assessing the quality of functionality for residential buildings.

For the assessment hierarchy of building environmental loadings, the values of consensus for criteria (Level 2) were evaluated and the values of consensus of "efficiency operation" (5.89) was lower than the threshold value and was exclusive of the assessment hierarchy. The results imply that efficiency operation may not be the important component for assessing the building environmental loadings of residential buildings. As a result, the assessment hierarchy for building environmental loadings was developed by integrating the experts' opinions (see Figure 3). As can be seen from the figure, this assessment hierarchy was composed of three categories and nine criteria. Nine criteria are designed to be the assessment items for assessing the building environmental loadings for residential buildings.

3.2 Evaluating the Weights of Components in the Assessment Hierarchies

In order to determine the weights of components for two assessment hierarchies, 14 expert questionnaires were collected. Experts were asked to compare a component at a pairwise basis in order to estimate the relative importance (scores from 1~9) to other components in the hierarchy. The consistency index and consistency ratio were calculated and two questionnaires were filtered out since the consistency ratio was greater than 0.1. As a result,

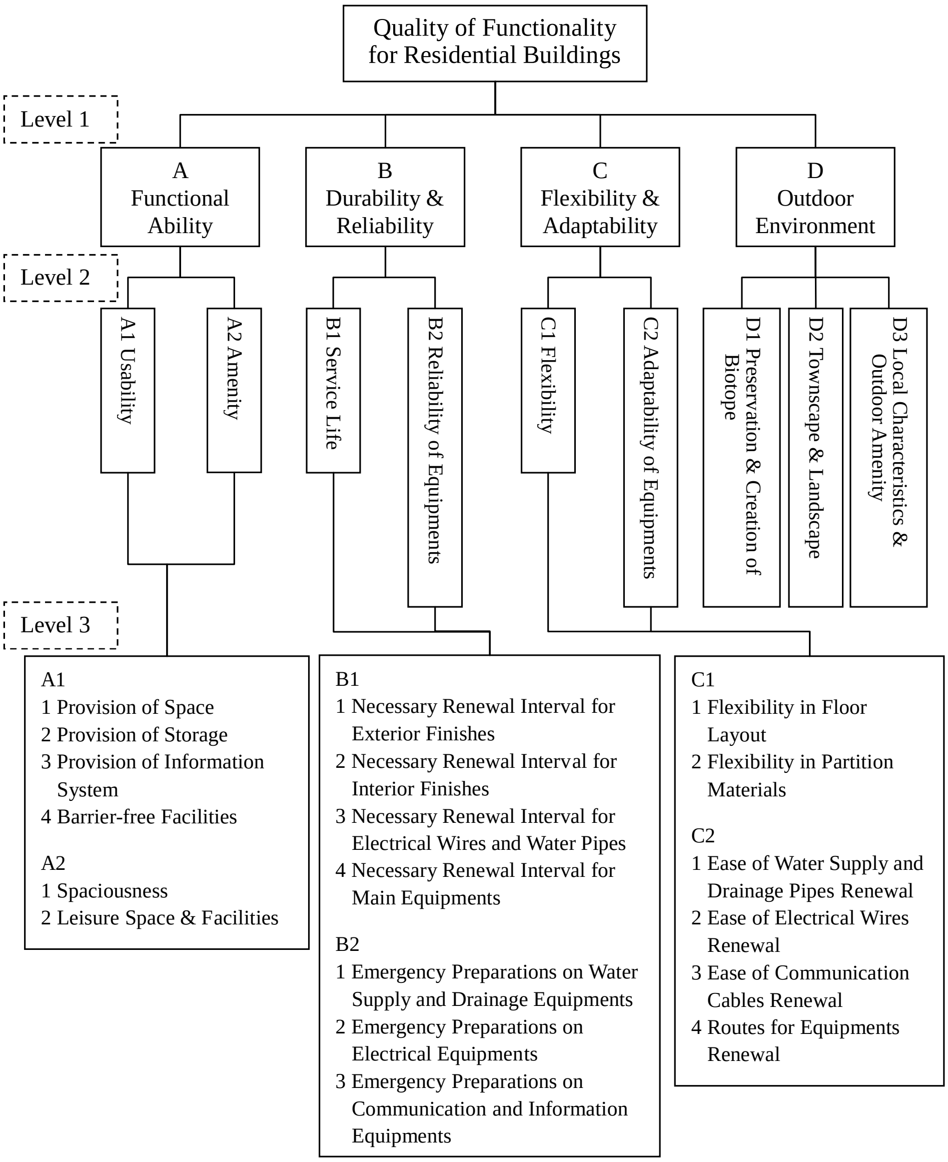


Figure 2: *The Assessment hierarchy for quality of functionality*

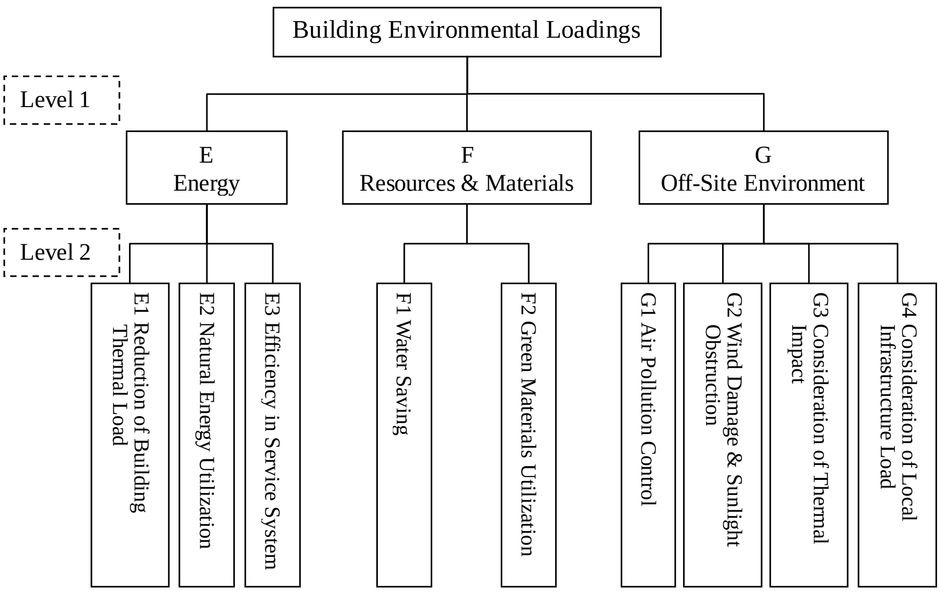


Figure 3: *The assessment hierarchy for building environmental loadings*

12 expert questionnaires were retained to the further analysis. The expert group included four architects, four officials and four scholars in related field of architecture.

As shown in Table 1, the weight of "A Functional Ability" is higher than other three categories in the assessment hierarchy for quality of functionality. These results reveal that architects or designers may pay more attention to the fundamental functions for residential buildings, which may be critical issues to the quality of functionality. The global weights of all assessment items also show in Table 1. As can be seen from the table, the weights of the assessment items in the categories "A Functional Ability" and "D Outdoor Environment" are higher than the assessment items in other two categories. Except the fundamental necessary "provision of space", the assessment items which have higher weights are related to social and environmental issues, such as the population aging, quality of life, and biodiversity. These results reveal that social and environmental issues which have received considerable attention also regard as important components in experts' opinions with respect to the quality of functionality for residential buildings.

Table 1. Global weights of assessment items in hierarchy for quality of functionality

Category	*Weight*	*Assessment Item*	*Weight*
A Functional Ability	0.521	A1-1 Provision of Space	0.202
		A1-2 Provision of Storage	0.048
		A1-3 Provision of Information System	0.041
		A1-4 Barrier-free Facilities	0.084
		A2-1 Spaciousness	0.069
		A2-2 Leisure Space & Facilities	0.077
B Durability & Reliability	0.143	B1-1 Necessary Renewal Interval for Exterior Finishes	0.006
		B1-2 Necessary Renewal Interval for Interior Finishes	0.011
		B1-3 Necessary Renewal Interval for Electrical Wires and Water Pipes	0.031
		B1-4 Necessary Renewal Interval for Main Equipments	0.031
		B2-1 Emergency Preparedness of Water Supply and Drainage Equipments	0.020
		B2-2 Emergency Preparedness of Electrical Equipments	0.031
		B2-3 Emergency Preparedness of Communication and Information Equipments	0.013
C Flexibility & Adaptability	0.145	C1-1 Flexibility of Floor Layout	0.038
		C1-2 Flexibility of Partition Materials	0.014
		C2-1 Ease of Water Supply and Drainage Pipes Renewal	0.037
		C2-2 Ease of Electrical Wires Renewal	0.033
		C2-3 Ease of Communication Cables Renewal	0.012
		C2-4 Routes for Equipments Renewal	0.011
D Outdoor Environment	0.191	D1 Preservation & Creation of Biotope	0.077
		D2 Townscape & Landscape	0.043
		D3 Local Characteristics & Outdoor Amenity	0.071

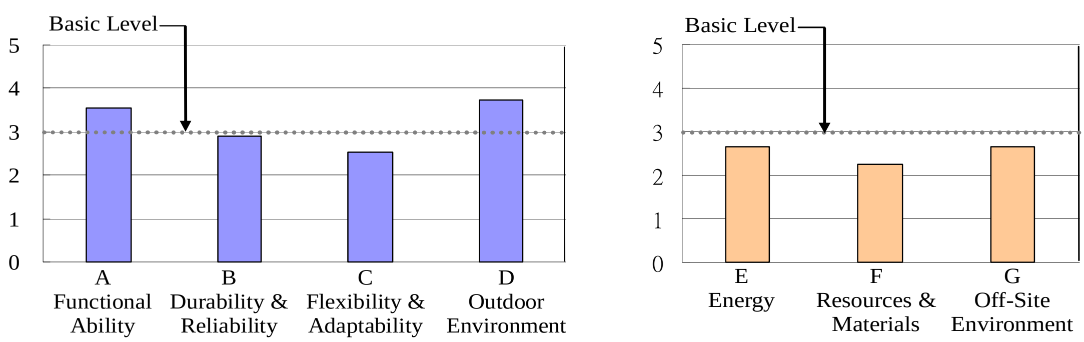
As shown in Table 2, the weight of "E Energy" is higher than other two categories in the assessment hierarchy of building environmental loadings. This result suggests that energy is an important issue for reduction of building environmental loadings. Moreover, "reduction of building thermal load", "natural energy utilization", "watering saving" and "consideration of thermal impact" have higher weights. These results reveal that resolving thermal issue, natural energy utilization and saving through design and management strategies might have higher environmental efficiency of functionality for residential buildings by the experts' opinions.

Table 2. Global weights of assessment items in hierarchy for building environmental loadings

Categorys	*Weight*	*Assessment Item*	*Weight*
E Energy	0.517	E1 Reduction of Building Thermal Load	0.260
		E2 Natural Energy Utilization	0.167
		E3 Efficiency in Service System	0.090
F Resources & Materials	0.212	F1 Water Saving	0.131
		F2 Green Materials Utilization	0.081
G Off-Site Environment	0.271	G1 Air Pollution Control	0.053
		G2 Wind Damage & Sunlight Obstruction	0.077
		G3 Consideration of Thermal Impact	0.106
		G4 Consideration of Local Infrastructure Load	0.035

3.3 Application Specification for Environmental Efficiency of Functionality

After the assessment hierarchies were developed and the weights of components in two assessment hierarchies were decided, the indicator proposed in this study could be used to evaluate the environmental efficiency of functionality for residential buildings. The procedures of evaluation are based on the CASBEE. First, quality of functionality and environmental loadings were calculated by the evaluation for all assessment items which are assigned to three levels. Three points shows the basic level, one point shows the poor level and five points shows the excellent level for each assessment item. The value of environmental efficiency of functionality is derived from the total scores for quality of functionality and building environmental loadings. Therefore, the environmental efficiency of functionality for residential buildings might indicate the level of each category for quality of functionality and building environmental loadings (see Figure 4) as well as the performance of functionality for the residential building. Moreover, the information might provide some implications for the renovation of existing residential buildings. It could find out the critical categories for renovation by comparing the scores of each category. Besides, it could be used in estimating the efficiency of improvement for functionality by evaluating the environmental efficiency of functionality before and after renovation for existing residential buildings. The information might help architects, designers or stakeholders to identify the more sustainable and efficient design or renovation.



(a) Quality of Functionality (b) Building Environmental Loadings

***Figure 4:** Example of assessment results for environmental efficiency of functionality*

4. CONCLUSION

The purpose of this study was to establish an indicator to evaluate the environmental efficiency of functionality for residential buildings in Taiwan. Two indices, quality of functionality and building environmental loadings, calculated separately and were transferred to the environmental efficiency of functionality. From the opinions of local experts, “Functional Ability”, “Outdoor Environment”, and “Energy” are the most critical issues for environmental efficiency of functionality in residential buildings. The indicator may be a supplementary indicator for building environmental assessment in Taiwan. In addition, it might be used to assess the critical categories for renovation and the environmental performance of improvement for residential buildings in the renovation stage.

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Maintenance and Management of Ecological Campuses
– A Case Study in West Cigu Campus, National University of Tainan

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ABSTRACT

National University of Tainan, Taiwan, strives to utilize ecological approaches in all aspects of campus landscape management and maintenance in its West Cigu Campus as it is situated near an ecological conservation area. Recommendations on water management include the building of stormwater detention ponds based on flood inundation probabilities evaluated by FLO-2D software, the installation of revetment of which the ground elevation is set in response to the tidal variations and water level changes after torrential rain monitored by water level measurement sensors in tidal creeks around the campus, and the constructed wetlands that deal with sewage disposal. On land management, GIS is adopted to determine the distribution of campus vegetation that contributes to the creation of ecological corridor, and ways of improving soil quality and a list of halophytes are put forward to maximize the survival of vegetation on the basis of soil salinity testing results. From the case studied, the research aims to present a model for the maintenance and management of ecological campuses.

KEYWORDS

ecological campus, maintenance and management, ecological conservation, constructed wetlands

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1. INTRODUCTION

1.1 Motivation

The littoral area of Southern Taiwan is renowned for its abundant wildlife resources and diverse ecological systems while Cigu Campus, National University of Tainan (NUTN) is surrounded by ecological resources and ecological conservation area for black-faced spoonbills. For maintaining the original status and preventing direct impact during campus development, feasible schemes should be undertaken in the future. Tainan County Government approved a gratuitous appropriation of 120 hectares of land in Shin-sheng Section, Cigu Township in 1998 for building new NUTN campus, with 38 hectares for East Cigu Campus and 82 hectares for West Cigu Campus. As West Cigu Campus is close to the habitat of black-faced spoonbills, the original ecological system must be retained under the development scheme. By utilizing the geographical conditions and conforming to the regulations and its philosophy of sustainable campus management, NUTU strives to be the first ecological university in Taiwan.

1.2 Research Purpose

Ecological conservation is the main idea of environmental preservation in Cigu Campus. Taking account of original geographical conditions, utilizing geographical advantages and resources, issues like flood control safety, domestic wastewater treatment and water resource reuse in the campus site can be accomplished by comprehensive planning and management and implementation of eco-conservation, in order to maintain ecological environment for indigenous inhabitant and vegetation.

2. THEORY AND METHODOLOGY

Discussion and planning had been carried out with NUTN administration, experts, scholars and program designers. Theoretical analysis of campus site was undertaken in both aquatic and terrestrial areas; site management was concluded through case study of related ecological campuses and areas in order to achieve ecological management and conservation plan.

2.1 Aquatic Area

2.1.1 Flooding

The flood simulation analysis was run by FLO-2D model. The analytic procedures and methods were based on "Reference Manual on the Regulation of Drainage and Planning of the Environment Rehabilitation" issued by Water Resources Agency (WRA).The data needed for flood simulation included terrain data from field measurement and rainfall data from neighboring rainfall station. The highest probability distribution versus the rainfall of respective return period was obtained via examination on the analysis of rainfall and rainfall frequency and the applicability of probability distribution. Adding hyetograph design and rainfall in flooding simulation, the result was generated. Three sides of the campus were right by the tidal ditch while the height of the bank protection was determined by water level changes caused by the tidal period, thus 6 observation posts for monitoring water level were installed at the outside edge of the campus in order to avoid being flooded by rain water.

2.1.2 Wastewater Treatment

The constructed wetland was built using ecological engineering approach for water pollution control. It can reach the same effect as the traditional wastewater treatment does, and benefit from features like power-saving operation, lower setup costs and easy maintenance. It also has additional values such as providing habitats for wild animals, and landscaping under the conditions of better water quality control and sufficient land area. For handling wastewater treatment issues in West Campus, constructed wetland with free water surface (FWS) system is more suitable to local ecological system as such systems have been implemented for over 30 years around the world. For instance, the Natural Treatment Systems has been used since 1980s in the U.S. to filter pre-treated sewage (by septic tanks or other means) for water purification. In the research, the planning for wastewater management strategies was based on the three-stage designing model for constructed wetlands proposed by the U.S. Environmental Protection Agency(EPA, 2000) as shown in Figure 1.

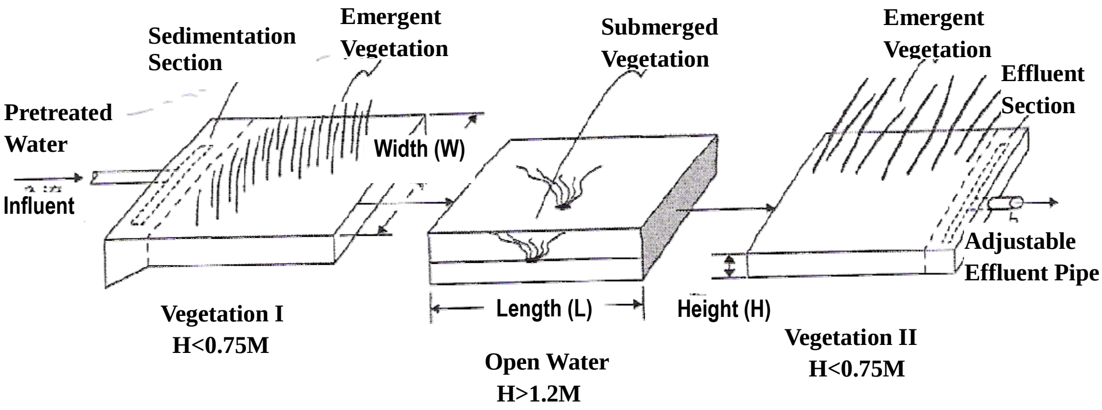

Figure1: *Three-stage Designing Model for Constructed Wetland s (suggested by US EPA)*

2.2 Land Area

2.2.1 Ecological Corridor

The Cigu Campus was once appropriated by local residents to raise fish and crops, therefore many natural habitats were destroyed and need to be reconstructed. Geographic Information System (GIS) was used to analyze ecological distribution, and the result was adopted for constructing ecological corridor and habitat. For remediation, maintenance and management of eco-environment and habitat reconstruction, eco-engineering approach was utilized. Shian-De Lin (2001) proposed his design of ecological corridor which is mainly composed of hedges, water ways, levees, roads and slope protection. Yet green belt and corridor does not have to be a continuous, sometimes it can be configured as checker-board-like spots for wildlife to move from one spot to another. Lin's design was based on the four principles of “Island Biogeography Theory" (Figure2), the foundation of eco-green network. The primary effects of the theory are: (1)Area Effects: The larger the green space, the more animal and vegetation will be conserved. (2)Edge Effects: If the edge of a green space is longer, it will receive more foreign impact. Given identical area, a circular one is better than a long and narrow one, while a square one is superior to a rectangular one. (3)Distance Effects: The closer the distance between green spaces, the easier for wildlife to migrate. (4)Connection Effects: When a great number of green spaces are inter-connected with zonal green corridors, wildlife's migration will be accelerated. The green corridor and space along the brooks can provide their important functions. Besides, irregularly configured green spaces will affect wildlife's migration, forage and courtship, even gene flow. According to German scholar Wildermuth H. (1980), animals can not leave well-covered green space too far (Table 1). This can be used as the basis for the configuring green belts within the campus.

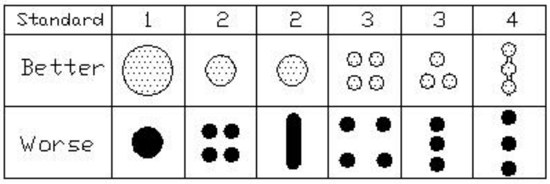

Figure 2: *Theory of Island Biogeography in Green Space Ecology*

Table 1. Maximum Movement of Animals Leaving Covered Green Space

Animals	*Beetle*	*Ant*	*Shrike*	*Chinese Bulbul*	*Frog*	*Shrew*	*Chinese Mink*	*Fox*	*Raccoon Dog*
Movement	50 m	50 m	50 m	150 m	150 m	200 m	250 m	300 m	1 km

Source: Shian-De Lin , 2001

2.2.2 Soil Salinity Testing

As the campus is situated near littoral area, for probing into the soil salinity and ensuring survival rate of planting, test method for chloride in water -- mercuric nitrate titration method, NIEA W406.52C, was adopted as a way to find out the soil salinity as well as monitor the environment, in order to provide strategies for growing salt-tolerant plants.

3. RESEARCH PROCESS AND RESULT

3.1 Flooding Area

The waters surrounding the campus were analyzed with FLO-2D, a 2-dimentional dynamic flood and mudflow routing model, to probe into the inundation potential in West Campus. The result (Figure 3) was adopted for setting up flood detention reservoirs, fish ponds, wetlands and marsh banks. With the assessment by FLO-2D and the observation on 100-year recurrence interval of the flooding area in West Campus before and after its land grading, it showed that flooding frequently occurred in the north-west corner of West Campus with a maximum depth of 1.5 meters.
Therefore the flood detention reservoir with 7.1 hectares of area and 1.5 meters in depth was set in this area for flood mitigation. It lowered the depth of flooding in west campus from 75 cm to 25 cm; if operated in conjunction with a fine drainage and fish pond water level control system, the flooding problem will be solved. Flood detention reservoir is curved and irregular in shape to extend the length of its void-structured bank. Dead woods and rock piles were placed in the reservoir to provide habitat for wildlife. In terms of water source and vegetation management, clean and stable water sources should be provided in order to maintain a diversified eco-system.

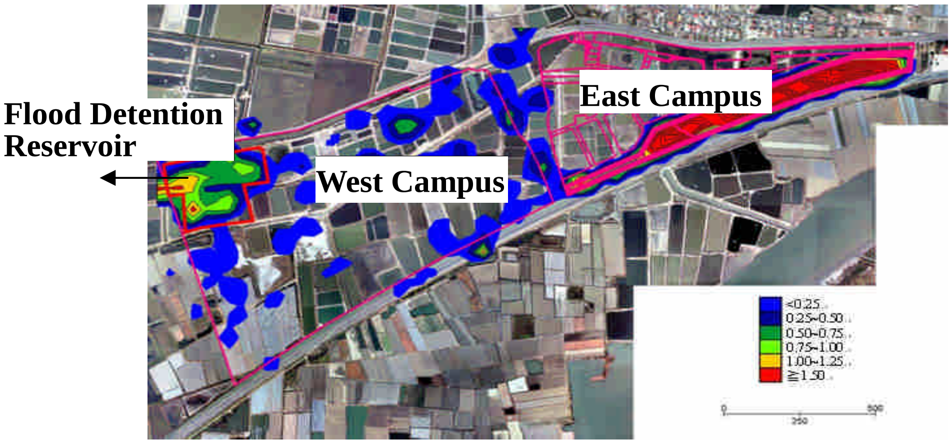

Figure 3: *Flooding Area in Cigu Campus, NUTN, Based on 100-year Recurrence Interval*

3.2 Tide level Observation at Tidal Ditch

The tidal ditch was built to stop water from flooding over the bank protection during high tide or high rainfall. Six water level sensors were installed on the south and north of Cigu Campus; 54 monitoring tests were undertaken from July 2007 to June 2008. (Table2) When typhoon Wutip came in August, 2007, sensor No.5 in the south of West Campus reached a highest record of 77 cm. The campus site engages with the outer branches of Zengwun River here, yet draining water away is not a problem. Overall assessment showed that tidal range at the ditch will be larger if torrential rain sweeps, but smaller, only about 20 to 30 cm when affected by daily tidal waves. The research suggested that the height of bank protection along tidal ditch at the south side should be over the highest water level record while the coefficient of safety should be also higher in order to keep the campus safe.

Table 2. A Comparison of Elevations of Tide at the Tidal Ditch

Sensor \ Elevation \ Times	1~6	7~12	13~18	19~24	25~30	31~36	37~42	43~48	49~54	EL highest	EL ranking
1	0.893	0.733	0.693	1.003	0.873	0.823	0.823	0.773	0.673	1.003	6
2	0.908	0.868	0.838	1.108	1.108	1.108	0.388	0.838	0.388	1.108	5
3	1.57	1.23	1.32	1.65	1.44	1.33	1.28	1.18	0.58	1.65	3
4	1.626	1.246	1.316	1.676	1.536	1.376	1.686	1.266	1.096	1.686	2
5	1.7	1.08	1.3	1.69	1.44	1.27	1.46	1.2	1.1	1.7	1
6	0.907	0.377	0.677	0.877	0.857	0.787	1.127	0.587	0.727	1.127	4

EL: Sea Level Elevation System

EL: Sea Level Elevation System

3.3 The Design of Constructed wetland

The constructed wetland was built to treat the wastewater generated by nearly 7,000 students in East Campus. As the sewage discharge is located at the southwest of East Campus, the constructed wetland in West Campus is positioned close to the East Campus. According to the wastewater quality in East Campus (Table3), influent wastewater is 1000 m3/day while Biological Oxygen Demand (BOD) is 160.0mg/L; the flow rate of effluent and reclaimed water is 999.8 m^3/day and the BOD is 8.0mg/L after wastewater treatment as demanded by regulation. Campbell (1999) formula was adopted for calculating the area of constructed wetland and hydraulic retention time (HRT).

Table 3. Mass Balance Calculation Sheet of Cigu Campus Sewage Treatment Plant

	Point Description	*Source*	*Flow rate*	*BOD*		*TSS*		*TN*		*Remarks*
			m^3/day	*mg/L*	*Kg/day*	*mg/L*	*Kg/day*	*mg/L*	*Kg/day*	
1	*Influent Waste Water*	1	1000.0	160.0	160	160.0	160	40.0	40	
2	*Equalization Tank Effluent*	1+7	1005.9	159.1	160	160.7	162	39.8	40	
3	*Bio-treatment Unit Effluent*	2-4	1003.8	8.0	8.0	8.0	8.1	10.0	10.0	
4	*Waste Sludge*	4	2.1	8.0	0.017	15000	31.6	10.0	0.021	
5	*Effluent and Reclaimed Water*	3-6	999.8	8.0	8.0	8.0	8.0	10.0	10.0	
6	*Dehydrator Filter Rinse Water*	–	4.0	8.0	0.03	8.0	0.03	10.0	0.04	
7	*Dehydrator Unit Filtrate and Rinse Water*	4+6-8	5.91	8.2	0.05	272.8	1.61	10.3	0.06	
8	*Dehydrated Sludge Cake*	–	0.19	–	–	–	30.0	–	–	

Source: NUTN, 2008

$$As = \frac{Q(\ln Co - \ln Ce)}{Kt \times D \times N} \quad \text{---- Equation (1)} \qquad As = \frac{1000(\ln 160 - \ln 8)}{0.983 \times 0.4 \times 0.65}$$

$$HRT = V/Q = As \times D \times N/Q \quad \text{---- Equation (2)} \qquad HRT = 11721 \times 0.4 \times 0.65/1000$$

In Equation (1): As= Wetlands Area =11,721 m^2

Q= Flow Rate of Influent Waste Water =1,000 m^3/day

Co= Influent BOD Concentration 160mg/L

Ce= Effluent BOD Concentration 8mg/L

Kt= Removal Rate Constant =0.983

D= Depth (m) =0.4

N= Void Ratio (wetlands with lush vegetation, set to 0.65)

In Equation (2): HRT= Hydraulic Retention Time=3 days

V = Volume (m^3)=11,721*0.4*0.65

Q= Flow Rate of Influent Waste Water =1,000 m^3/day

Setting influent waste water flow rate to 1,000 m^3/day in East Campus as a standard, 1.2 hectares of constructed wetlands should be needed in West Campus, and should be further expended for eco-landscaping. The wetland should be built by stage: 2 hectares in first stage and 4 hectares in second stage. There are free water surface (FWS) and subsurface flow (SSF) system for constructed wetland, but NUTN adopted FWS system as SSF system needed to backfilled the wetland with large amount of sand and stones and would be overly artificial, uneconomical, and difficult to keep clean. FWS system consists of influent inlet, vegetation area I, open water, vegetation area II and effluent outlet. (Figure4) Referring to the decontamination and degradation ability of constructed wetland toward nitrogen, phosphorous, SS, BOD and COD, the Aquatic vegetation planted was shown in Table 4 as suggested by Cing-Guang Wun (2007). According to US EPA, 4 to15 days of HRT is suggested. If the HRT is longer, the pollutant concentration in effluent will be lower and water quality will be better. Yet water treatment capacity will be reduced (Meng-Heng Shih & Shian-De Lin 2006) .

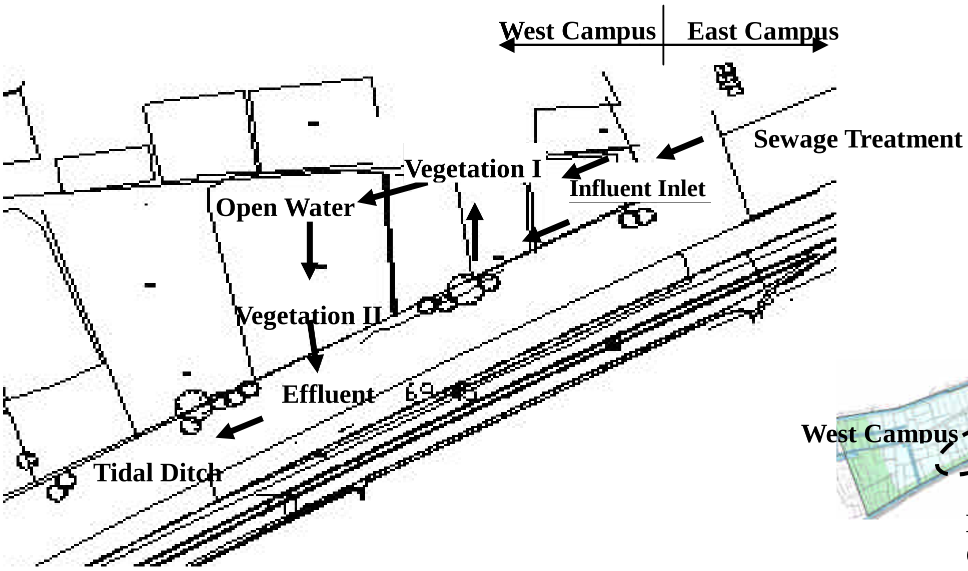

Figure 4: *Plan of Constructed Wetland*

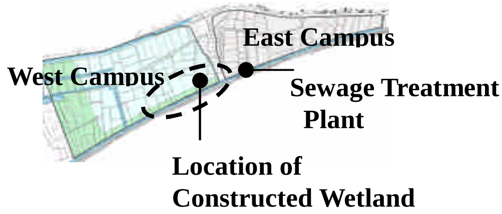

Figure 5: *Location of Constructed Wetland*

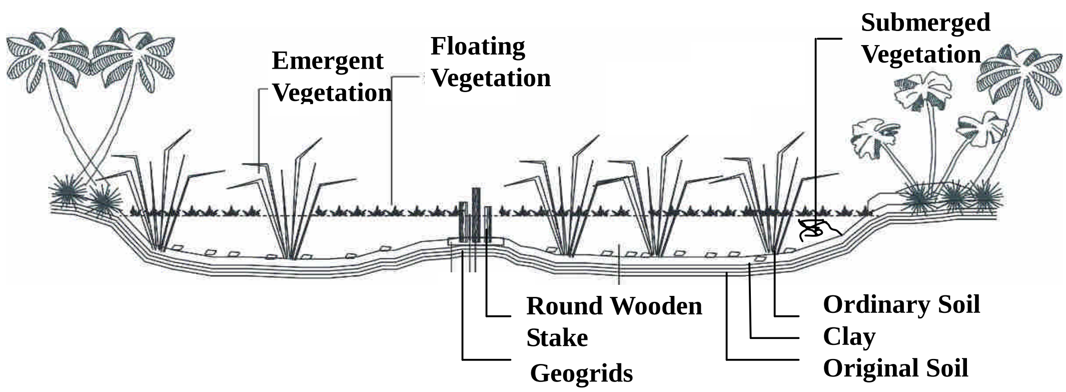

Figure 6: *A Cross-sectional View of Constructed Wetland*

Table 4. Recommendation for Wetland Vegitation

Zone	*Category*	*Recommendation*	*Spacing for Each Plant*	*Depth of Water*	*Days Retaining*
Vegetation I	Emergent Vegetation	Cattail, Cyperus Alternifolius, Reed	20cm	40cm	2
	Floating Vegetation	Water Hyacinth, Water Lettuce	30cm		
Open Water	Emergent Vegetation	Ludwigia X Taiwanensis Peng, Water Chestnut, Phragmites vallatoria	30cm	130cm	2
	Floating Vegetation	Clover Fern, Trapa japonica, Yellow Water Lily			
	Submerged Vegetation	Potamogeton Crispus (Curly Pondweed), Ottelia alismoides, Limnophila trichophylla Komarov,			
Vegetation II	Emergent Vegetation	Hydrophila pogonocalyx Hayata, Ludwigia octovalis (Jacq.) Raven	20cm	40m	2
	Floating Vegetation	Azolla, Common Duckweed, water spinach	30cm		

Source: Cing-Guang Wun ,2007, Meng-Heng Shih , Shian-De Lin ,2006 & EPA,2000

3.4 Result of Geographic Information System (GIS)

As for land area, the research adopted GIS to find out the distribution of various land characteristics within Cigu Campus, and worked in conjunction with the eco-island theory and the sustainable eco-network philosophy concerning green space, in order to form a remediation plan for ecological green space in land area. According to the result, in West Campus, the places with more green belts are flood detention reservoirs on the northwest, the currently disused nursery garden on the southwest, constructed wetland southeast, and the existing fish ponds and marsh on the northeast. As for geological distribution rate referring to GIS statistics, 41.6 hectares of fish ponds accounted for 51% , 26.1 hectares of wasteland for 32%, 7.3 hectares of dry farmland for 9%, 3.3 hectares of roads for 4%, 1.6 hectares green belts for 2%, and 1.5 hectares of tidal ditch for 2%. (Figure7) The construction of ecological green net in land area is conformed to the distribution of above-mentioned green belts and the plan for roadside vegetation and ecological island.

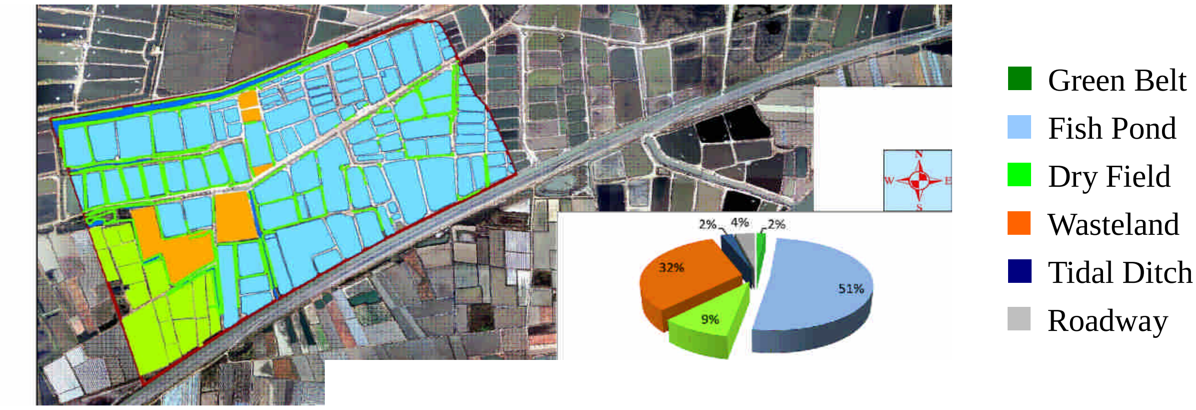

Figure 7: *GIS Analysis of West Campus, NUTN*

3-5 Salt Injury Test Result on and Countermeasures

Jing-Ping Yang (2002) indicated that salt tolerances among common trees are varied; some will die if it is over 3 g/kg. In this research, soil salinity was tested for totally 12 times at 6 test spots in Cigu Campus most of the test values were higher than 3 g/kg. (Table5) which indicated that vegetation in Cigu Campus should be with higher salt tolerance to survive referring to Shin-Huei Lin's and Chun-Yen Chang's (2005) recommendation. (Table6) The strategy for soil salinity control was that for newly planted trees, For soil salinization, applicable countermeasures are: (1)Soil Washing: soak soil into water for a period of time repeatedly to remove salt from soil.(2)Soil Modification: replace the soil that accumulated salt with salt-free soil.(3)Planting Cleaning Crops: rotate cropping to reduce soil salinity.

Table5. Soil Salinity Test Record

Sampling Location		*Test Items Salinity in Soil (g/kg)* 07/10/2007	12/12/2007	*Remarks*
East Campus	*A*	19.4	18.5	
	B	15.3	11.6	
	C	11.8	14.6	
West Campus	*D*	10.3	10.3	
	E	3.47	6.87	
	F	1.25	9.16	

Source: Tsing-Hua Technology Co. Ltd., 2009

Table 6. Recommendation for Salt Tolerant Vegetation

Tree Species	*Vegitation Recommended*
Trees	Portia Tree, China Tree, Indian Almond, 、Pongam Tree, Odollam Erberus-tree, Hernandia Nymphiifolia (Presl) Kubi, Ring-cupped Oak, Formosan Aglaia, Indiapoon Beautyleaf, Formosan Nato Tree, Pittosporum Pentandrum, Phoenix Hanceana Naudin, Beefwood, Pithecellobium Dulce, Washingtonia Filieara, Calocedrus Formosana, Excoecaria Agallocha, Liodendron Formosanum, Distylium racemosum Sieb. & Zucc., Idesia polycarpa Maxim, Pourthiaea lucida Decaisne
Bushes	Lumnitzera racemosa Willd, Screw pine Scaevol, Beach Morning-glory, Slivery Messerschmida, Five-stamens china laurel, Boxleaf Eugenia, Colubrina Asiatica
Ground Cover	Ruellia brittoniana Leonard, Sesuvium portulacastrum (L.) L., torpedograss, Paspalum vaginatum Sw., Wedelia biflora (L.) DC., Wild Morning-glory, Operculine Tuperthum. (L.) S. Mansq.

Source: Shin-Huei Lin & Chun-Yen Chang, 2005

3.6 Zoning Plan, Road System and Windbreak Forest

The research avoided changing the original terrain features, thus the campus was divided into 3 major areas: "Ecological Conservation Park", "Research Park" and "Education Park" (Figure8) with regard to terrain features. Among them the Ecological Conservation Park was further divided into nursery garden green area, ecological lake area and mangrove area; Research Park was zoned as constructed wetland and solar power research area; Education Park was separated into wind power research area and windbreak forest area. (Figure9)

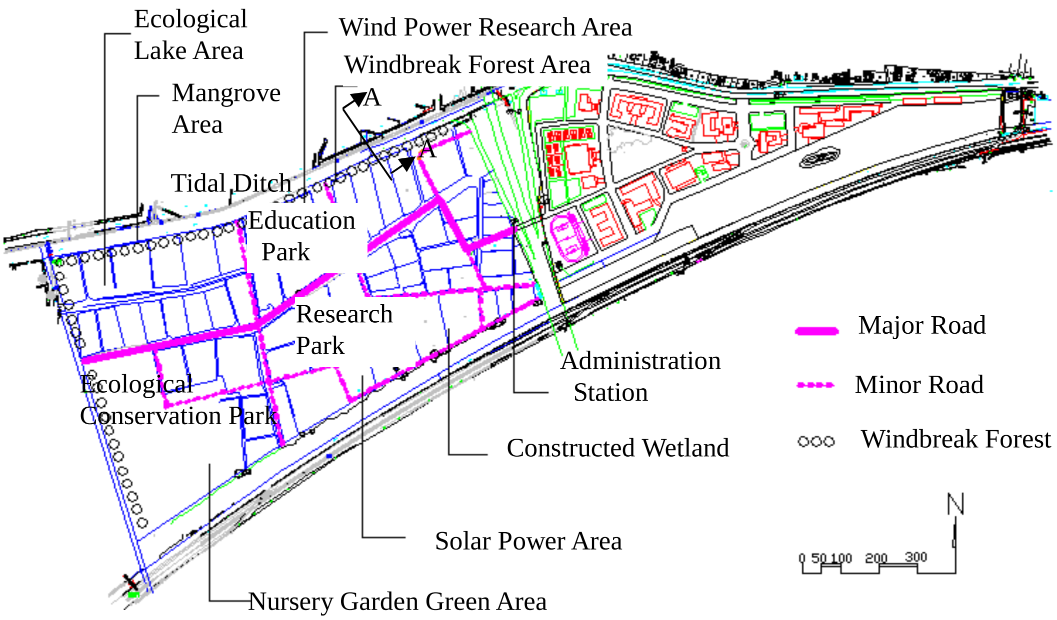

***Figure 8:** Land-use Zoning Plan of Cigu Campus, NUTN*

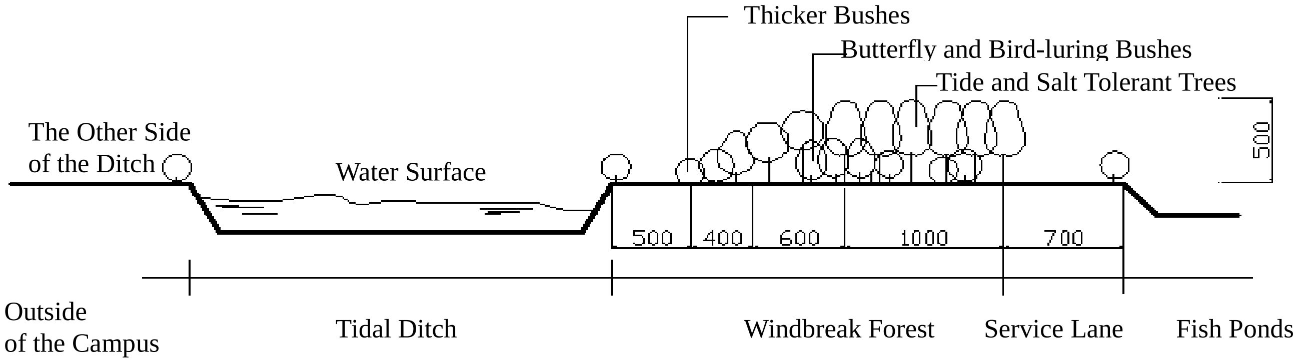

***Figure 9:** Cross-Section Diagram of Windbreak Forest A-A*

4. CONCLUSION

The research utilizes the concept of the creation and recovery of sustainable ecological system with ecological engineering to set up a mechanism for ecological campus maintenance and management. As for the aquatic eco-engineering, the most critical issue is the flood within the campus. In addition to the construction from flood-controlling riverbank at the outter rim of the campus site to the flood detention reservoirs at the possible flooding area, water level observation devices should be installed for permanent water level monitoring. Although wastewater treatment system using aquatic plants as filter can provide both landscaping and water treatment, due to ill management, it frequently causes water eutrophication that contains overly high content of nutrient salts such as nitrogen and phosphorus, and results in mass-production of algae covering water surface and consequently death to plants and aquatics from lacking of oxygen. Therefore mechanical filtering system can be added at the wastewater inlets as supplemental equipment for wastewater treatment. For terrestrial eco-engineering, the idea is to construct habitats ideal for local wildlife; that is to say to configure diversified vegetation communities based on "eco-island theory" in order to set up ecological corridors for wild animal. However, in addition to setting up windbreak forests and soil improvement for countering local sea wind and soil salinity, plants in unfavorable growing condition should be replaced periodically, so as to maintain a well-preserved eco-system and beautiful landscape. Overall, the critical work of ecological campus management and maintenance should be done by setting up a perfect ecological monitoring system, for both aquatic and terrestrial areas, as a early warning measure for following changes and ill management of the campus environment, in order to support the campus's sustainable development.

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The New System to Assist Examining the Construction License

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ABSTRACT

To effectively simplify construction license application procedures and expedite license issuance efficiency, Building Administration Office of Taipei City Government started promoting reform in construction license administration system from 1 March 2008 through *re-reviewing administration approval*, *re-reviewing co-handling details for construction license*, *standard documents and illustrations*, and *making administration examining item teaching materials for construction license* in cooperation with professional architects at Taipei Architects Association; the entire process of license issuance now is reduced to 28 days from 199 days, which greatly enhanced administration efficiency and provided citizens with rapid, convenient, public and transparent construction license examining information.

KEYWORDS

Perform pre-examination.

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1. Introduction

Citizens have been complaining about lengthened time of construction license application, as corrections were not informed in one time. By March 2008 (30 October 2007 to 29 February 2008), a total of 176 cases had been approved and the public felt that the total time to complete construction license application was 199 days (in which architects spent an average of 155 days; Building Administration Office and Administration Office of Taipei City Government spent an average of 44 days, making the total of 199 days). The reasons for disapproval included examinations on application sites (examination of urban development design plans and examination on environmental impact evaluation) or site conditions affecting public interests or traffic.

In combination with private human resources, Building Administration Office of Taipei City Government worked with Taipei Architects Association to cover the manpower shortage at Building Administration Office and provide citizens with rapid and professional examination consultation service in order to simplify construction license application procedures. We started trial of construction license assistance inspection system from 1 March 2008 and formally promoted construction license examination assistance on 1 October 2008. We introduced a lot of measures to simplify administration procedures including *establishing association assisting in examination, re-reviewing administration approval details, re-reviewing co-handling details for construction license, standard documents and illustrations,* and *making administration examination item teaching materials for construction license*. Publicity and education was made via the Internet and large seminars to improve administration efficiency in order to provide citizens with rapid, convenient, public and transparent construction license examination information.

2. Promoting the new system to assist examining the construction license

2.1 Instructions of the system

2.1.1 Instructions of the system

Association assistance in examination is to treat selected architects at Taipei Architects Association as the extension of manpower of Building Administration Office to facilitate people.

2.1.2 Instruction of legal foundation

The legal foundation for construction license examination under assistance of Taipei Architects Association is Article 34 of Building Act and Article 16 of Administrative Procedure Act.

2.1.3 Instruction of commissioned activities

2.1.3.1Assisting and viewing construction license application in Taipei City.

2.1.3.2Assisting Building Administration Office of Taipei City Government in examining major examination items on construction license.

2.1.4Instruction of commissioned examining

Building Administration Office of Taipei City Government commissioned Taipei Architects Association to examine the following:

2.1.4.1 examining items designated by Ministry of Interior.

2.1.4.2 auditing items as per administration submission for approval scope.

2.1.4.3 consultation of professional architecture auditing items

2.1.5 Things to be completed by unit assisting examining

2.1.5.1 Examining progress and results after assistance in construction license examination shall be made in one detailed rejection, specifying the defects; handling progress and names of personnel assisting examining and the time will be available on the website at the same time.

2.1.5.2 Establishing scope of operation of personnel assisting examination, including examining procedures, self-discipline behaviors, assessment main points and self-discipline agreement

2.1.6 Instruction of examining methods of assisting personnel:

2.1.6.1Providing construction illustrations and examination criteria list.

2.1.6.2Due to high inaccuracy rate in construction illustrations, we prepared examination criteria and standard example as reference of architects and construction personnel (**Figure** 1).

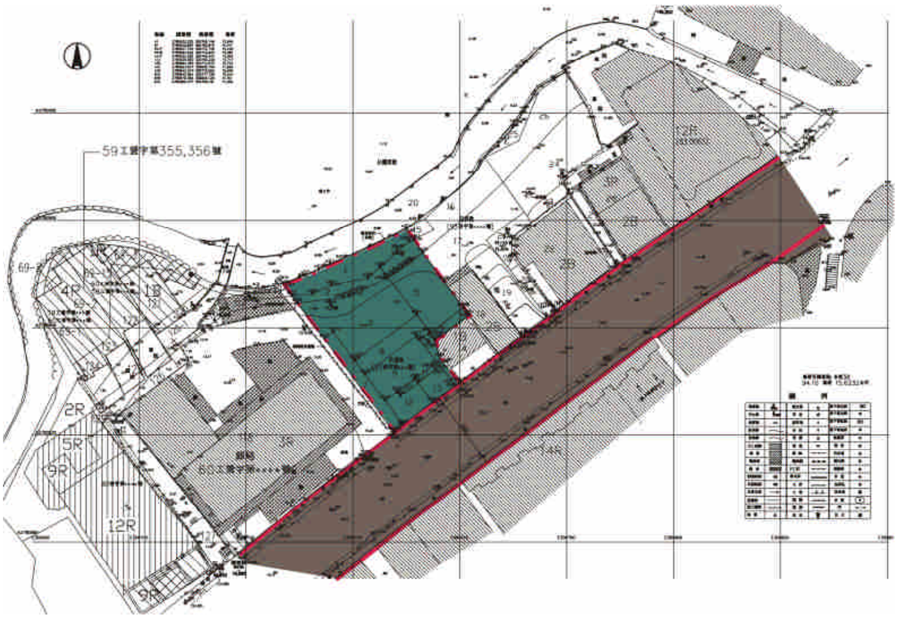

Figure 1: *Sample of Field Survey Map of Current Situation*

2.1.6.3 Offering construction license administration examination item education training teaching materials for the public, architects and architects assisting examination

There are a great number of construction license administration examinations in

Taipei City with different notice, items and procedures. The construction industry and architects assisting in examining are not familiar with administration examination procedures (mountainous lands, fragmental lands, etc). We then prepared teaching materials in education training for construction license examination assistance (**Figure** 2) to make items in administration items, contents and procedures in construction license examination assistance clear and definite.

Making publicity brochures for construction license examination assistance system.To make citizens and architects understand how the system is implemented and the notice, we made the brochure in Q&A, detailing the construction license examination assistance application procedures and administration items (**Figure** 3).

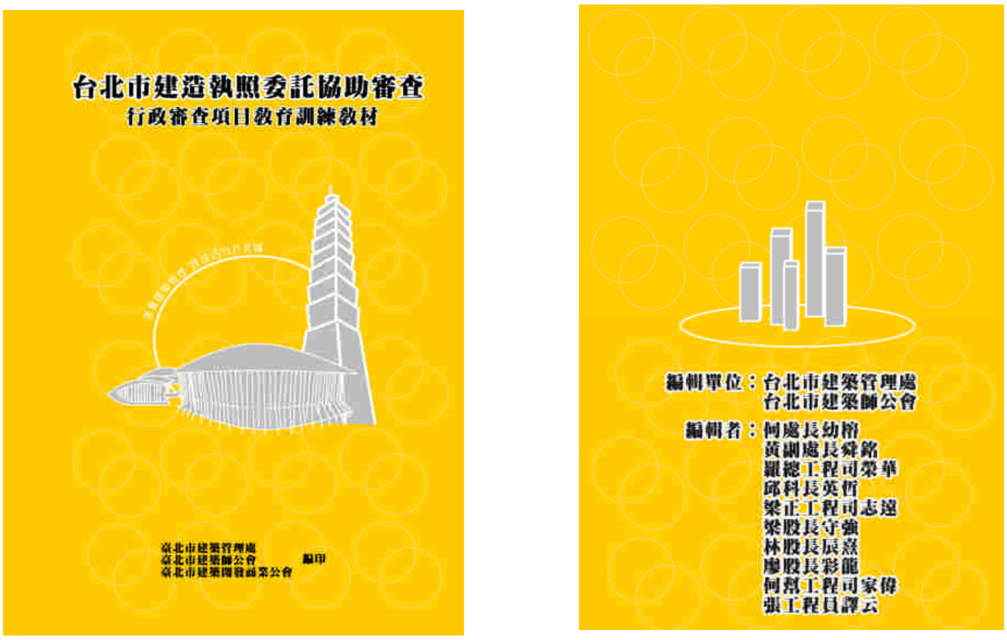

Figure 2 Teaching Materials for Administration Examination Item Education Training

Figure 3 Brochure of Taipei City Construction License Commissioned
Assistance in Examining

Specifying construction license examination assistance procedures

After verification of equalizations for construction license by Taipei Architects Association, the application is arranged into examination (Figure 4); assisting architects confirm the co-held items. Applicants (proprietors or architects) prepare the required information for examination in parallel division (Division A, the Office or Department of Renewal: Divisions B to D, institutes of the Office, Division F, outside units (Ministry of National Defense, Bureau of High Speed Rail, MOTC). After verification by examination assisting unit, information is sent to each examining unit through electronic document exchange. The units shall complete examination within the required time. After completion assisting in examination, Building Administration Office of Taipei City Government issues construction license.

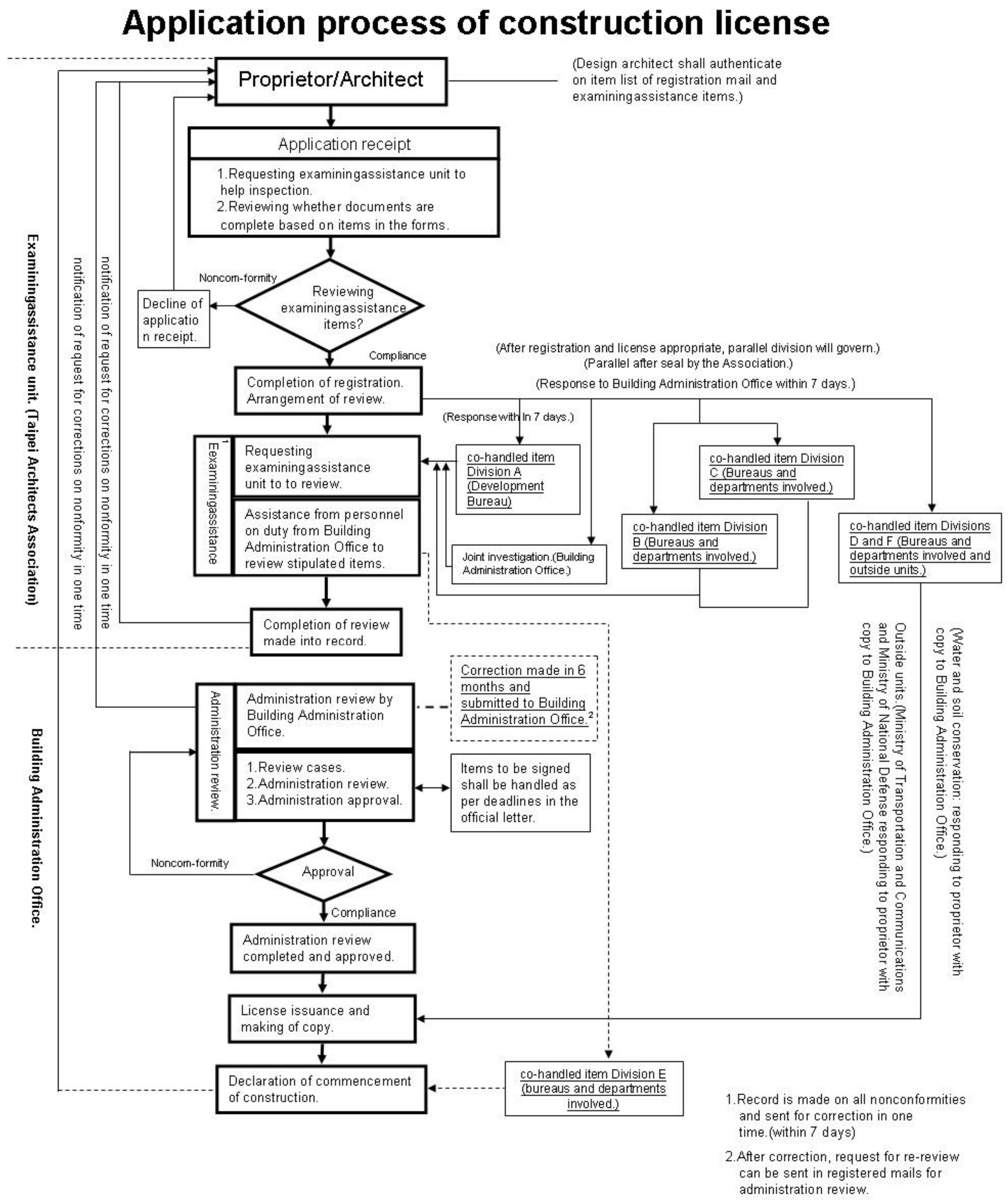

Figure 4 ***Construction License Examination Assistance Procedures***

2.2 Re-reviewing parallel division system

2.2.1 Purpose: reducing co-handling process to expedite administration efficiency
2.2.2 Implementation methods:
2.2.3Current implementation unchanged for forwarding by competent authority (of construction) under the Building Act or other laws and regulations
2.2.4No stipulation in the Building Act or other laws and regulations: co-handling not required, to be handled by each competent authority
2.2.5 Items to be handled:
2.2.5.1Building Administration Office of Taipei City Government first arranges items to be co-handled in construction license application and items to be completed after approval of license to review if there are items free from co-handling.
2.2.5.2Checking whether there are items to be co-handled after license
2.2.5.3Checking whether there are items from co-handling control
2.2.5.4Where cross-department/office co-handling is required, submit to the highest parallel for negotiation.

2.2.5.5Final results:

Building Administration Office of Taipei City Government, after re-reviewing construction license co-handling matters, has made re-division and arranged laws and decrees and application forms of co-handling units and reconfirmed the timing required. Other than 30 days on water and soil conservation examination by Department of Economic Development, Taipei City Government, other departments and offices will only take 7 days.

For application involving units outside Taipei City Government such as restricted areas by Ministry of National Defense (30 days) and Bureau of High Speed Rail, MOTC (7-14 days), we have verified documents required and examination time in parallel division.

2.3 Re-reviewing administration approval content plan

2.3.1 Purpose: reducing the time of administration approval to expedite efficiency
2.3.2 Implementation methods:
2.3.3Administration approval on items of division of responsibility by Building Administration Office of Taipei City Government is replaced with Architect Auditing General Form (irregular sites/bonus suspension cases/general design/high chlorine ion capacity rewarding) to shorten administration approval time.
2.3.4Building Administration Office of Taipei City Government division of responsibility approval level was revised to expedite license issuance without affecting license issuance quality.
2.3.5 To-do list: we started revising administration division of responsibility level details of Building Administration Office of Taipei City Government in the hope that administration personnel no longer need to handle administration approval or expanding authorization to reduce administration item approval levels.
2.3.6Final results:
2.3.6.1Establishing construction license document examination key points: 44 document receipt criteria were established; establishing criteria for required documents by architects in practice in Taipei City
2.3.6.2Supplementing instruction of construction license document examination key points:

detailing the notice of the 44 criteria to help the public, applicants, architects and involved personnel to have a look beforehand and serve as education training materials for people at Building Administration Office

2.3.6.3Making the example of required illustrations and documents of construction license in Taipei City: the 44 criteria are made into example for reference of architects in practice in Taipei City and involved personnel

2.3.6.4Making general administration item auditing form: to simplify administration item approval, we made 16-item form to shorten approval time. The preceding materials are available at website of Building Administration Office of Taipei City Government.

3. Comparison between the new and old systems

Building Administration Office of Taipei City Government made statistics of top ten rejection reasons before the construction license examination assistance system (Table 1). The main reason is design units failed to investigate site current situation environment or incomplete documents and illustrations. The receipt criteria by Building Administration Office on construction license were too low (only 14 items were reviewed). As long as the documents met the 14 criteria, register could be made (obtaining applicable act date). Under the Building Act, and Article 8 of Building Administration Office of Taipei City Government Self-government Ordinance, we increased the construction license receipt criteria to 44 items to avoid fighting for registration and reduce notification of correction; as the criteria were enhanced, documents were complete and we could expedite construction license examination.

Table 1 Analysis of Top 10 Reasons of Rejection

Number	*Item*	*Number of cases*	*Ratio*
1	Incomplete field survey map making	30	16%
2	Incomplete application form	28	15%
3	Involving fragmental lands (mediation)	23	12%
4	Incomplete pictures of current situation	17	9%
5	Incomplete information of proprietors, designers and constructors	17	9%
6	Not approval under urban examinations	16	8%
7	Lack of instructions of fence, walls/free from application for miscellaneous license or joint application for construction licenses /fines	15	8%
8	Failing to review aviation height	14	7%
9	Failure of reviewing of disability list	13	7%
10	Incomplete agreement of the right to use the land	12	6%

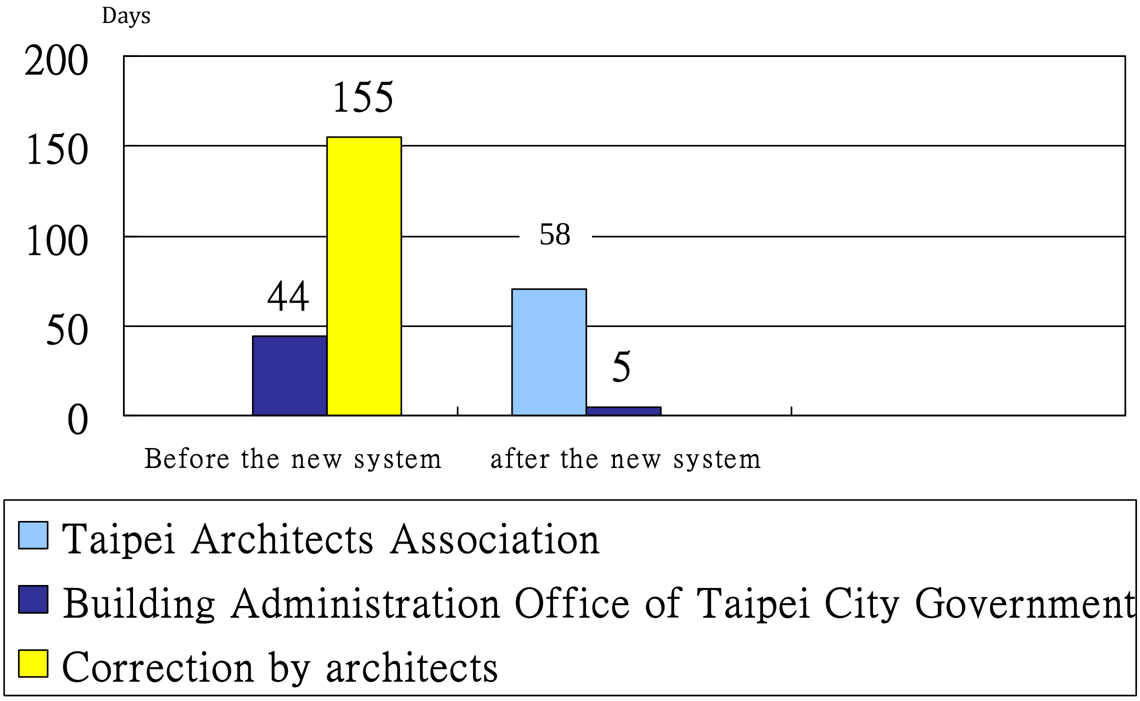

Figure 5 Expected Performance of the New System

As per **Figure 5** on comparison before and after the new system (August), once the documents are complete without doubt in laws and regulations and administration approval, after examination assistance by Taipei Architects Association, license can be issued within 3-7 days (3 days for buildings with less than 6 floors, 5 days for 7-15 floors and 7 days for over 16 floors). The applicants could feel much shorter waiting time.

With professional assistance from Taipei Architects Association, joint investigation and handling time was shortened; most of construction license administration examination items could be corrected by members under instruction of Taipei Architects Association to shorten construction license application time

4. Instruction of effects of the new system

4.1 Shortening the waiting time people felt

After the construction license examination assistance system (1 March to 30 September 2008), Taipei Architects Association assisted Building Administration Office of Taipei City Government in construction license application receipt; the criteria were increased from 14 to 44 items. A total of 232 applications were received among which 23 cases were approved without rejection (10%), showing an initial progress of 100% rejection before; the average time to issue construction license before 1 March is 199 days (44 days by Building

Administration Office and 155 days by correction from architects). From 1 March to 30 September, after assistance from Taipei Architects Association, the average time to approve by Building Administration Office of Taipei City Government wash shortened to 96 days.

After the construction license examination assistance system with standardized application receipt, parallel document handling, expansion of free from approval and administration authorization, the average waiting time of the public is 21 days (1 October 2008 to 31 July 2009) (**Figure 6**).

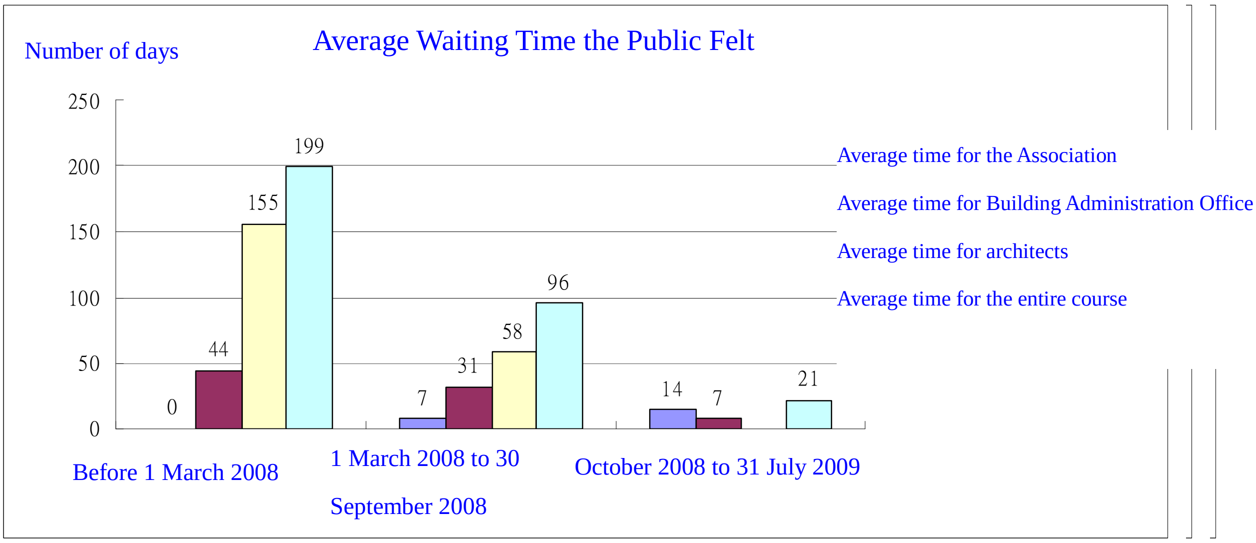

Figure 6 Average Waiting Time the Public Felt

4.2 Enhancing one-time construction license approval rate

4.2.1 Application receipt of construction license:

Taipei Architects Association receives construction license applications per construction license first time registration criteria, 242 cases were accepted; 24 were rejected right away. Acceptance rate is 90.9% (Table 2).

4.2.2 Construction license examination assistance:

From 1 October 2008, Taipei Architects Association assisted in construction license examination on the afternoons of Mondays, Wednesdays and Fridays. Number of cases of acceptance in one time is 243(58%). Direct approval rate slightly increased; 161 cases were rejected to make correction (42%). The Association has established construction license progress control mechanism to ask architects to expedite construction license examination. Provided proprietors and design architects fail to apply for re-examination within one month, the Association will notify them to (Table 2).

5. Future prospects

5.1 Improving service efficiency

After the new system, around over 70 architects as per list by the Association assisted in examination, supplementing the insufficient manpower at Building Administration Office. The manpower will expand service to the citizens and groups in Taipei City. In the future, we hope to have more architects to assist after education training.

Table 2 Construction License Examination Assistance

	Application receipt			Examination by Association		Examinations by the Office		
Item / Month	Approval registration	Non-approval registration	Total	Association approval	Rejection for correction	Cancellation	Approval	Under approval
July 2009	43	6	49	32	11	6	31	0
June 2009	57	6	63	17	40	4	23	0
May 2009	29	4	33	26	3	4	22	0
April 2009	44	4	48	41	3	5	28	0
March 2009	42	3	45	23	19	3	35	0
February 2009	28	5	33	25	3	0	19	0
January 2009	32	5	37	21	11	2	22	0
December 2008	44	1	45	38	6	1	38	0
November 2008	48	3	51	18	30	1	12	0
October 2008	48	7	55	13	35	0	13	0
October 2008-July 2009	415	44	459	254	161	26	243	0
Changes amount	-14	0	-14	+15	-29	+2	+8	0
Remarks	Application receipt=examination under the 44 receipt criteria by the government							
	Examination by Association: examination on 171administration examination items that we require. In nonconformity, we notify the proprietors in one time for correction under Article 36 of the Building Act.							
	1. The 1st notice: 30 days after request from the Association for correction when applicants fail to submit correction for re-examination 2. The 2nd notice: 5 months after request for correction (1 month before the due date of the application) from the Association							

5.2 Transparent, open and more convenient for the public

With assistance of Taipei Architects Association in examining construction license, the procedure is open and transparent, reducing the doubts and disputes from the public and shortening the examination time.

5.3 Building database of urban plan, construction management, urban renewal and other laws and regulations

We have now implemented new system of construction license examination assistance. Relevant laws and regulations and interpretations are not complete.Working with administration departments and professional groups, we will build more comprehensive database of laws and regulations for applicants and architects.

5.4 Improving use license approval rate and enhancing construction management quality

Building Administration Office of Taipei City Government and Taipei Architects Association promote the new construction license examination assistance system on 1 October 2008. We will review and improve construction management system (including construction safety, material quality control, water and soil conservation and neighborhood security) and expedite use license issuance to have a human friendly, safe, comfortable and access free environment with maintaining long, sustainable development to keep appearance of natural ecology for a city of energy saving, resource recycling and respect of culture full of green buildings.

Sustainable building at the right perceived value of the real estate market

Kuei-Feng Chang[1]
Po-Cheng Chou[2]

ABSTRACT

Due to the whole people attach more importance to the sustainability of the structures influenced by the warning of global climate change and energy use up. The real estate market not only faced the change of market need ,but also faced the influence on sustainable building , cause the sustainable building assessment tool to gradually be used for a base of the project development permit, building bulk premium, property mortgage risk assessments etc… on construction, property and finance sectors. Therefore, this investigation integrated the additional value of sustainable building that included the aspect of economical society, environment and explored the influence on the real estate market.

This study adopted the AHP method to carry on the questionnaire. The object of the test in this study included the experts and the publics, the experts were related to construction and the real estate field. The experts' questionnaires were 50 released; it was 33 copies hat effective sample is counted, and 66% of effective rate of recovery. And the publics' questionnaires were 70 released, it is 51 copies that effective sample is counted, and 73% of effective rate of recovery. The empirical result showed that the experts and the publics were priority to take account of the sustainable building performance, there are: "F. Natural Environment (Climates and Ecosystems)" (0.201), "B Energy and Resource Consumption" (0.188), and "E. Indoor Environmental Quality" (0.187).

KEYWORDS

Sustainable building; Real estate market; Perceived value

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1. INTRODUCTION

As the warning of the global climate change and energy exhausted, etc., many consumers, developer and builder that begin to be fond of a green or sustainable building (Wen, 2002; Fang, 2005; Lin, 2007). The real estate market not only faced a change of the market need, but also faced an influence on sustainable building. Thus, it cause the sustainable building assessment tool to gradually be used for a base of the project development permit, building bulk premium , property mortgage risk assessments etc… on construction, property and finance sectors (Thomas, 2006), and also expanded the influence of sustainable building on the real estate market.

The approach based on the concept of the perceived value and proposed a review of the sustainability performance and sustainable value added for the sustainable building and through a questionnaire method to survey specialists that related the real estate market field. The aim is to improve the interested parties or actors of the real estate market have the knowledge of sustainable building performance and to provide the government for foundation of promoting the policy on the real estate building projects, and for the academic to discuss the developing direction on the sustainable building.

2. A LITERATURE REVIEW

2.1 Sustainable Building Assessment Tools

This study considers a particular set of the selection sustainable building assessment system (Chang, 2007), combines European Property and Market Rating and the international current main assessment tool [Table 1]. This research hoped to structure items for the questionnaire from the compared criteria of the sustainable building assessment.

2.2 Sustainable Value Added for the Sustainable Building

Greg Kats' (2003) stated sustainable buildings generally incur a "green premium" above the costs of standard construction. They also provide an array of financial and environmental benefits that conventional buildings do not. These benefits, such as energy savings, should be looked at through a life cycle cost methodology, not just evaluated in terms of upfront costs. From a life cycle savings standpoint, savings resulting from investment in sustainable design and construction dramatically exceed any additional upfront costs. The analysis indicates that total financial benefits of green buildings are over ten times the average initial investment required to design and construct a green building.

Green buildings also provide the benefits include some elements that are relatively easy to quantify, such as energy and water savings, as well as those that are less easily quantified, such as the use of recycled content materials and improved indoor environmental quality associated with these "green" features include enhanced worker and student productivity, as well as reduced absenteeism and illness (Wilson et al., 1998; Heerwagen, 2000; Yates, 2001; Greg Kats', 2003).

Thomas (2007) indicated that Sustainable buildings squeeze the maximum utility for owners, users and the wider public out of the lowest possible use of land and throughput of energy and raw materials. These buildings are not necessarily more expensive to build from the outset than conventional ones, but their ownership results in various direct and indirect financial benefits for investors and other stakeholders, ranging from drastically lower operating costs to improved marketability, longer useful life spans, more stable cash flows, reduced exposure to increasingly stringent environmental legislation, and significantly increased occupant productivity and well-being. Furthermore, the property rating methodology (TEGoVA, 2003) which is currently to adopt and develop further by a number of German banks does contain rating criteria that allow treating un-sustainability as property risk factors. This may finally lead to preferential lending conditions for sustainable buildings. Table 2 shows the bands which provide the preferential lending conditions for considering environment and energy resources saving of sustainable building performance.

Table 1. The current rating systems and criteria list

Assessment method	*Developer*	*Criteria*
European Property and Market Rating	The European Group of Valuers Associations (TEGoVA)	(relaterd to sustainability) Building materials; Energetic performance/ energy demand/ energy consumption ; Emissions
SBTool	iiSBE	Site Selection, Project Planning and Development; Energy and Resource Consumption; Environmental Loadings; Indoor Environmental Quality; Service Quality; Social and Economic aspects; Cultural and Perceptual Aspects
ISO/ TS21931-1	International Organization for Standardization	Environmental Aspects of Buildings; Environmental Impacts of Buildings; Building Management ; Indoor Environment
LEED-NC(US)	U.S. Green Building Council	Sustainable Sites; Water Efficiency; Energy & Atmosphere ; Materials & Resources; Indoor environmental quality; Innovation & Design Process
BREEAM(UK)	Building Research Establishment	Management; Health and Wellbeing; Energy; Transport; Water; Material and Waste; Landuse and Ecology; Pollution
CASBEE	Ministry of Land, Infrastructure and Transport Japan GreenBuild Council (JaGBC)/ Japan Sustainable Building Consortium (JSBC)	Divided into Q(Building Environment Quality & Performance) and LR(Reduction of Building Environmental Loadings). Q : Q-1 (Indoor Environment), Q-2 (Quality of Service) and Q-3 (Outdoor Environment on Site) LR: LR-1 (Energy), LR-2 (Resources& Materials) and LR-3 (Off-site Environment).
EEWH	Architecture & Building Research Institute (A.B.R.I.), Ministry of the Interior, Taiwan	Biodiversity; Greenery; Soil Water Content; Energy conservation; CO2 Emission; Waste Reduction; Indoor Environment; Water Resource; Sewer and Garbage

Table 2. Summary of the low-interest loans of banks for buildings considering environment performance

Country	*Bank*	*Task*
Germany	Kreditanstalt Fur Wiederaufbau (KfW)	To provide the preferential lending conditions with respect to energy conserving improvements or energy conservation measures for the new and existing buildings
Sweeden	Various banks	Almost the smaller banks grant a loan of high energy efficiency, including lower interest loan rate and longer time of loan
USA	Frannie Mae and Department of Housing and Urban Development	To provide the preferential lending conditions with respect to energy conserving improvements or solar energy systems or residential energy conservation measures
USA	Indigo Financial Group	Offer longer loan time, and the cost which improves energy efficiency can be attached to the regular price of the real estate
UK	Norwich and Peterborough Building Society	Green low-interest loans, and lower than bank rate by 0.25% discount to grant the loan at the first two years.
UK	Co-operative Bank	Green low-interest loans

To summarize, these above-mentioned sustainable added value literatures can divide the influences that directly into environment, economy, and society three dimensions. The questionnaire will base on three aspects to explore the sustainable building added value for the real estate market.

3. RESEARCH MOTHODOLOGY

3.1 The AHP method

In order to examine the perception of the interested parties (occupant, investor, developer, real estate broker, designer, government agency and so on) of the real estate market, this paper applies the AHP (analytic hierarchy process) method.

The AHP method is an intuitive method for formulating and analyzing decisions (Saaty, T. L., 1980). It can help to improve the decision-making process and has been applied to numerous practical problems in the last few decades (Shim, J. P., 1989). The AHP modelling process involves four phases, namely, structuring the decision problem, measurement and data collection, determination of normalized weights, and synthesis-finding solution to the problem (R. Ramanathan, 2001). The hierarchical structure used in formulating the AHP model can enable all members of the evaluation team to visualize the problem systematically in terms of relevant criteria and sub criteria. The team can also provide input to revise the hierarchical structure, if necessary, with additional criteria. Furthermore, using the AHP, the evaluation team can systematically compare and determine the priorities of the criteria and sub criteria.

3.2 Questionnaire Design

This AHP model consists of the Goal and Criteria. In order to the assortment of criteria, the sub-criteria are filled in with suitable indicators, this questionnaire content is selected from the primary building environment assessment systems of SB-Tool, ISO／TS 21931-1, LEED, CASBEE, BREEAM and EEWH. So, there are six criteria sorted out for the AHP model and included: A. Sustainable Site, B. Energy and Resource Consumption, C. Environmental Loadings, D. Service Quality, E. Indoor Environmental Quality, and F. Natural Environment (Climates and Ecosystems). That is, these criteria are set up the hierarchy and sub- criteria only outline of corresponding topmost level criteria. Table 3 classified the selection criteria and sub-criteria of this questionnaire.

Table 3. A summary of the selection criteria and sub-criteria of the primary building environment assessment systems

Selection Criteria	*Selection Sub-Criteria*
A. Sustainable Site	A1.Site Selection A2.Public Facility Assess A3.Project Planning A4.Urban Design and Development Density A5.Cultural Values.
B. Energy and Resource Consumption	B1.Renewable Energy B2.Structure(s) Reuse B3.Water Efficiency B4.Energy Conservation Deign B5.Use of Recycled Materials
C. Environmental Loadings	C1.Use of Green Materials C2. Solid Wastes C3.Impacts on Site C4.Rainwater, Stormwater and Wastewater C5. Heat Island Effect
D. Service Quality	D1.Efficiency of Space Utilization D2.Maintenance of Operating Performance D3.Maintenance of Core Functions During Power Outages D4.Ability to Modify Technical Building Systems D5.Commissioning of Facility Systems D6.Adaptability Constraints Imposed by Structure
E. Indoor Environmental Quality	E1.Noise and Acoustics E2.Daylight and Illumination E3.Low-Emitting Materials E4.Ventilation and Indoor Air Quality E5.Air Temperature and Relative Humidity E6. Magnetic Pollution
F. Natural Environment (Climates and Ecosystems)	F1.Greenery F2. Biodiversity F3.Site Design for Native Flora Habitat F4.Conservation of Native Fauna Habitat F5.Soil Water Content

3.2 Sample

This paper adopted the judgment sampling of the non-probability sampling to survey, also called purposive selection which is characterized by the use of judgment and a deliberate effort to obtain representative samples by including presumably typical areas or groups in the sample.

This research is through the questionnaire to study the different guilds (investor, consumer, building trader and developer, etc…) of the domestic real estate market how recognize the sustainable performance of buildings. So the respondents include the professionals of 'government agency', 'industrial circles', 'academia', and the non- professionals.

Therefore, this study sends out 50 copies to investigative experts and 70 copies to examine investigate non-experts. The expert questionnaire received back 35 copies which give an obtainable rate of 70%, and the other questionnaire received back 58 copies which give an obtainable rate of 85%. After filtering out the null questionnaire, then there were 33 expertise copies belonging to the valid questionnaire and the other are 51 copies. Figure 1 provides a breakdown of the valid respondent responses by professional and non- professional groups.

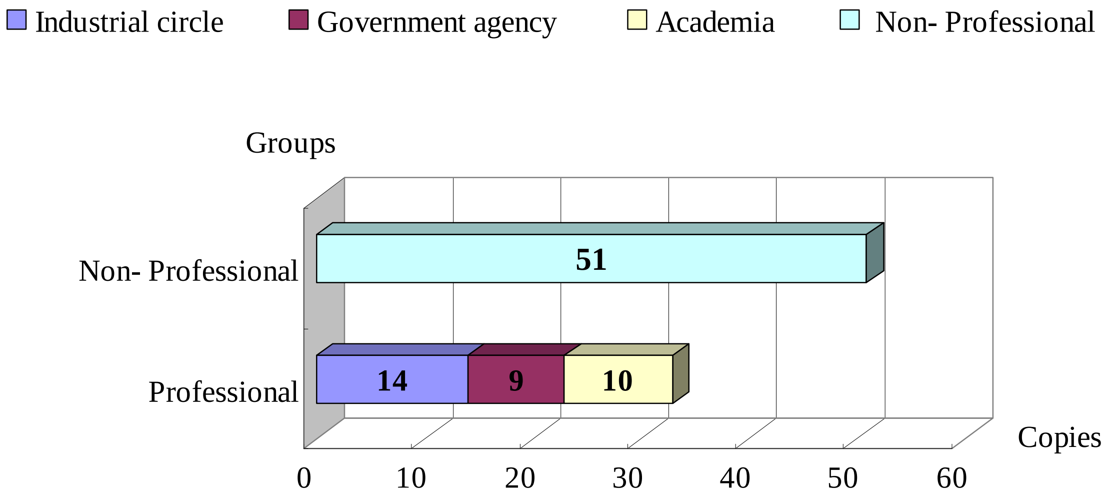

Figure 1: *The distribution of the valid questionnaire by the investigation*

4. ANALYSIS AND DISCUSSION

This AHP approach derives the weights of the different groups using intrinsically derived ratings of each group, which compares itself with the other groups. The result indicates the opinions from the all responses on the recent period and the domestic situation.

The subsequent analysis based on "T-test" and "F-distribution" of ANOVA approach to assess the statistical differences of the investigated values between "the classified groups", and compare with all responses. Aim to identify what is the most influential parameter of the sustainable building performance.

4.1 Findings

The AHP analysis result of the "Criteria" level from the all questionnaires, of which the weighting is listed in sequence: "F. Natural Environment (Climates and Ecosystems)" (0.201), "B Energy and Resource Consumption" (0.188), "E. Indoor Environmental Quality" (0.187), "C. Environmental Loadings" (0.160), "D. Service Quality (0.134), and "A. Sustainable Site" (0.130). From the results of the experts of which the weighting is listed in sequence: "B Energy and Resource Consumption" (0.198), "F. Natural Environment (Climates and

Ecosystems)" (0.190), "E. Indoor Environmental Quality" (0.175), "C. Environmental Loadings" (0.169), "A. Sustainable Site" (0.136), and "D. Service Quality" (0.132). The weighting value of the non-professional survey listed in sequence: "F. Natural Environment (Climates and Ecosystems)" (0.221), "B Energy and Resource Consumption" (0.182), "E. Indoor Environmental Quality" (0.180), "C. Environmental Loadings" (0.156), "D. Service Quality (0.135), and "A. Sustainable Site" (0.126).

To summarize the distributive findings of the three groups: all responses, the professional, the non- professional, especially the weighting value of the three criteria: "C Environmental Loadings", "B Energy and Resource Consumption", and "E. Indoor Environmental Quality" obviously exceeded the other three criteria. It means that "C Environmental Loadings", "B Energy and Resource Consumption", and "E. Indoor Environmental Quality" are the critical issues of sustainable building performance for the interested parties of the real estate market in the present Taiwan. This weight finding of the criteria for all responses can be seen in figure 2.

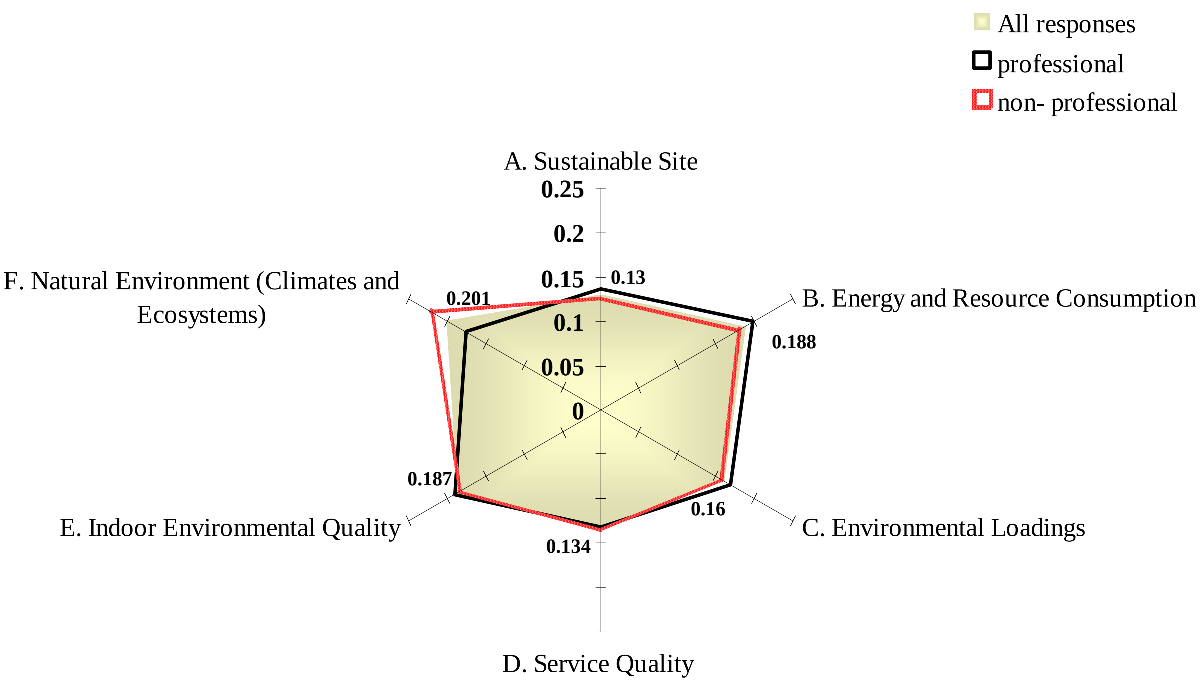

Figure 2: *The weighting value distribution of the all response*

The analysis of variance between the investigated values of the professional group and the non- professional group is: only the "F. Natural Environment (Climates and Ecosystems)" aspect presented ｜T-value｜>｜Critical value｜. The T-test is significant at P-value <α (0.05) and then other criteria are no differences between the professional group and the non-professional group. Thus it indicated the people would like to consider more on the factors of "Greenery, Biodiversity, Native Flora Habitat and Conservation of Native Fauna Habitat". The T-test result is shown in Table 4.

Table 4. T-test for the professional and the non- professional on the investigated criteria

Criteria	*Professional*	*Non-Professional*	*T-value*	*DF**	*P-value (two-tailor)*	*Critical value*	*Statistically significant*
A. Sustainable Site	0.136	0.126	0.6265	82	0.5327	±1.9894	NO
B. Energy and Resource Consumption	0.198	0.18	1.0949	82	0.2768	±1.9894	NO
C. Environmental Loadings	0.169	0.156	0.1761	82	0.8606	±1.9894	NO
D. Service Quality	0.132	0.135	0.2444	82	0.8076	±1.9894	NO
E. Indoor Environmental Quality	0.19	0.182	0.1360	82	0.8921	±1.9894	NO
F. Natural Environment (Climates and Ecosystems)	**0.175**	**0.221**	**-2.1064**	**82**	**0.0382**	**±1.9894**	**YES**

* DF=Degree of freedom; n= (Professional sample33) + (Non- Professional sample51)-2=82

4.2 Comparison among the classified expert groups

The AHP analysis result of the “Criteria” level from the industrial circle questionnaires, of which the weighting is listed in sequence: “E. Indoor Environmental Quality” (0.212), “B Energy and Resource Consumption” (0.189), “F. Natural Environment (Climates and Ecosystems)” (0.186), “C. Environmental Loadings” (0.154), “D. Service Quality (0.151), and “A. Sustainable Site” (0.108). From the government agency of which the weighting is listed in sequence: “C. Environmental Loadings” (0.198), “F. Natural Environment (Climates and Ecosystems)” (0.179), “A. Sustainable Site” (0.179), “B Energy and Resource Consumption” (0.166), “E. Indoor Environmental Quality” (0.16), and “D. Service Quality” (0.118). The academia survey listed in sequence: “B Energy and Resource Consumption” (0.243), “E. Indoor Environmental Quality” (0.183), “C. Environmental Loadings” (0.162), “F. Natural Environment (Climates and Ecosystems)” (0.154), “A. Sustainable Site” (0.142), and “D. Service Quality (0.115). This weight of the expert groups can be seen in figure 3.

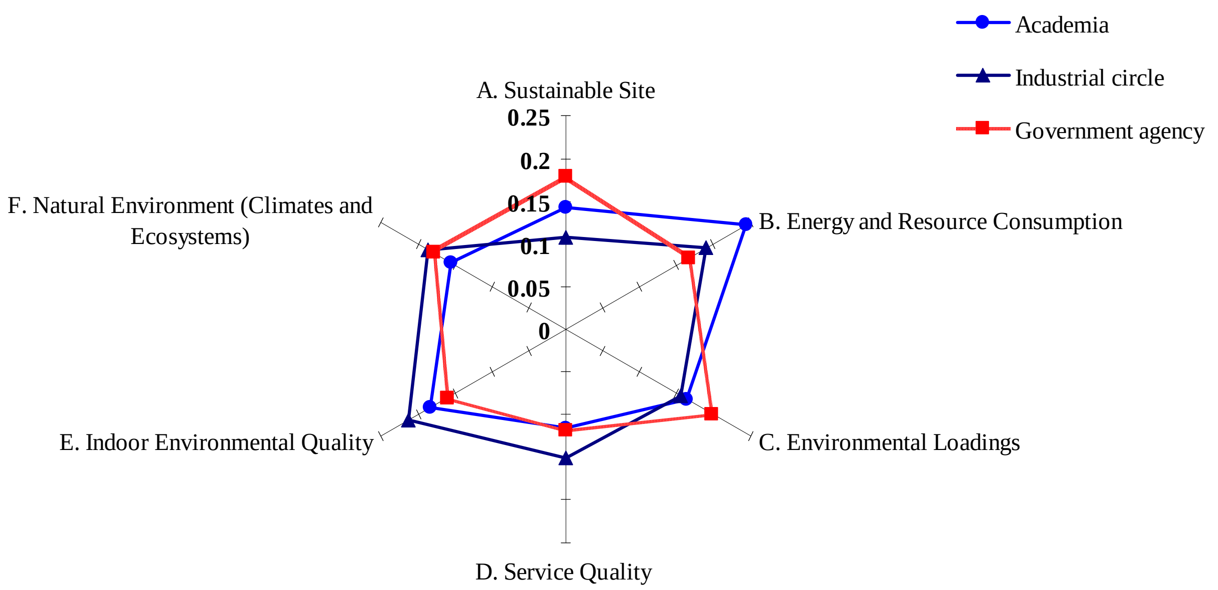

***Figure 3:** The weighting value distribution of the three expert groups*

To summarize the distributive findings of the three expert groups: the weighting value of the criteria respectively: the industrial circle is “E. Indoor Environmental Quality”, the government agency is “C Environmental Loadings”, and the academia is “B Energy and Resource Consumption”, and obviously exceeded the other criteria. It means the critical issue of sustainable building for the experts regard with the different perceived value.

Consider these classified expert groups composed of three independent samples: industrial circle, government agency, and academia. The next step utilizes F-test involving the examination of the difference. In table 5 it is seen that F-value< ∣Critical value∣, and proves that there is no differences among the three classified professional groups is true.

Table 5 F-distribution for industrial circle, government agency and academia expert groups on the investigated criteria

Criteria	*Industrial circle*	*Government agency*	*Academia*	*F-value*	*DF**1	*Critical value**2	*Statistically significant*
A. Sustainable Site	0.108	0.179	0.142	1.7212	30	3.3158	NO
B. Energy and Resource Consumption	0.189	0.166	0.243	1.2623	30	3.3158	NO
C. Environmental Loadings	0.154	0.198	0.162	0.6611	30	3.3158	NO
D. Service Quality	0.151	0.118	0.115	0.9572	30	3.3158	NO
E. Indoor Environmental Quality	0.212	0.16	0.183	0.7715	30	3.3158	NO
F. Natural Environment (Climates and Ecosystems)	0.186	0.179	0.154	1.0183	30	3.3158	NO

*1 DF=Degree of freedom; n= (Total sample33)-3=30
*2 Critical value: F-value <3.3158, there is significant difference among theses three independent samples

5. CONCLUSION

Base on the selected criteria of the sustainable building performance, this study can provide the feasible weighting values to evaluate the right perceived value of the real estate market for the interested parties in the present Taiwan. The results can be summarized in the following points:

(1) The AHP result of all opinions outlines the priority issue in Taiwan. There are: “F. Natural Environment (Climates and Ecosystems)”, “B Energy and Resource Consumption” (0.188), “E. Indoor Environmental Quality”. It indicates the whole people attach more importance to the sustainability influenced by the warning of global climate change and energy use up.

(2) The real estate market interested parties practically pay more attention to the residential quality and the additional value those advantages that related to the sustainable performance. On the other hand, there is difference among the professional groups that the

academia and official especially consider the environmental sustainability, but pass over such the market demand and then delay to promote the sustainable building policy.

(3) Overall, the criterion of "B Energy and Resource Consumption" is highly respected both by the professional groups and non-professional. It meant people to show more consideration to the issues, of "energy conserving improvements, energy conservation measures, reuse, and use of recycled materials...and so on", for the new and existing buildings. Namely, theses are the most significant issues of sustainable building performance for the interested parties or actors of the real estate market to consider, and a right direction for the government to promote.

6. ACKNOWLEDGEMENTS

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SECTION 2

INTEGRATED DESIGN – THE CHANGING ROLE OF AEC ORGANISATIONS

Feng Shui: A Chinese approach to integrated design

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ABSTRACT

Feng Shui is a body of ancient Chinese knowledge that aims at creating a harmony between environment, buildings and people. It has influenced most traditional building design in China for thousands of years. With a desire to improve the relationship between human and the environment, there is an increasing interest for architects and other building professionals to apply the concepts of Feng Shui in building design and the built environment. However, the development of Feng Shui principles and practices are complicated and there is little research into the application of Feng Shui knowledge to the built environment and architectural design. It is suggested that interpreting Feng Shui knowledge would enable the development of a design tool from this Chinese architectural discipline. In particular, the Form School of the Feng Shui knowledge provided a holistic approach that allows integrated components and elements to be considered for the built environment. This paper investigates the principles and practice of Feng Shui and its knowledge structure to provide a broad understanding of the Feng Shui knowledge. A hierarchical structure of Feng Shui knowledge is presented which would form a useful basis for integrated design.

KEYWORDS

Feng Shui, Chinese approach, Form School, integrated design

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1. INTRODUCTION

Building design is complex. A building is viewed as an interdependent system, as opposed to an aggregation of its separate components (site, structure, and services). Integrated design is a collaborative method for designing buildings which emphasizes the development of a holistic design. The goal of looking at all the systems together is to make sure they work in harmony rather than against each other. This integrative design process is similar to the Chinese holistic view and the Feng Shui approach to the built environment (Humphreys, 1976).

Feng Shui is a body of ancient Chinese wisdom in knowledge and experience related to the built environment that has been accumulated for more than three thousand years. It is founded from the earliest and greatest philosophy document of Chinese, *Yi Jing* (The Book of Changes) that developed ca. 800 B.C. The primitive knowledge of Feng Shui was based on the observation from three sources: astronomical phenomena, natural phenomena and human behaviour (Feuchtwang, 1974).

The principles and practices of Feng Shui aimed at creating a harmonised built environment for people to live in, and it represents a traditional Chinese architectural theory for selecting favourable sites as well as a theory for designing cities and buildings (Lee, 1986). There are two main schools of thought and practice in Feng Shui: the Compass School and the Form School (Mak and So, 2009). The Form School approach has been well recognized and widely accepted by Feng Shui researchers as comprising the scientific bases in the analysis of built environment (He, 1990; Cheng and Kong, 1993). The Form school established a holistic approach that allows integrated components and elements to be considered for the built environment (Mak and Ng, 2008).

Since the late 1960’s the impact of western civilisation and technology has grown to global proportions, more western scholars became aware of the limitations of the modern scientific paradigms that failed to explain the whole realm of natural phenomena and began to recognize that there are similarities between modern science and eastern philosophy (Capra, 1975). Lee (1986) recognized that traditional interpretations based on the formal, spatial and technical data of architecture cannot adequately explain the context and meaning of this Feng Shui architecture. He suggested that interpreting Feng Shui would enable the development of architecture theories from this Chinese architectural discipline.

Nowadays, as many researchers seek to establish a deeper understanding of these relationships between the human and natural environments, architects begin to recognize Feng Shui as a broad ecologically and architecturally connected paradigm. Hwangbo (1999) believed that the practice of Feng Shui is an intuitive matter involving site selection and spatial organization, and it has strong parallels with the western concept of geometry in architectural design.

This paper investigates this Chinese approach for integrated building design derived from the principles and practice of Feng Shui. Firstly, the principles and practices of Form School approach are briefly explained and hence the four fundamental concepts are derived. Finally, a hierarchical structure of Feng Shui knowledge is presented which would form a useful basis for integrated design.

2. FORM SCHOOL APPROACH

There are two main schools of thought and practice in Feng Shui: the Compass School and the Form School. The Compass School is based on metaphysical speculations of cosmology, in particular by analysing the directional aspects in terms of the relationship between the five elements, eight trigrams, heavenly stems, earthly branches and constellations. Practice in the Compass School uses primarily the *Luopan* (Feng Shui compass) and the composed elements of time in space (Skinner, 1982; Chiou and Krishnamurti, 1997). The Form School is primarily based on the verification of the physical configuration of mountains and watercourses surrounding sites and buildings. Its theory was built upon an understanding of the landscape: the profiles of the land, the sources of rivers and the terrain. The practice of the Form School first observes the land formation and terrain, and then determines the location and orientation of buildings.

The development of the Form School was widely accepted by the upper class of the ancient Chinese society and attracted scholars and intellectuals to join its practice. The principles of the Form School were applied to design and construct castles, palaces and towns in China since ancient times (He and Luo, 1995). Lee (1986, p.367) suggested that the principles and practices of the Form School approach represent "a compendium of Chinese architectural theory". For example, major cities in China (He and Luo, 1995), Beijing courtyard houses (Xu, 1998), and villages in Hong Kong (Mak, 2009), are all design and built according to the Form School approach.

Since the Ming Dynasty (1368-1644), these two schools of thought were not exclusively attached to their own methods for the practice of Feng Shui, but rather combined and integrated ideas from both Compass and Form schools (Lee, 1986). However, the Form School approach remained the primary consideration in Feng Shui practice (Xu, 1990; Too, 1996). Contemporarily, Form school approach has been recognized as comprising scientific basis in the analysis of the built environment (He, 1990; Wang, 1992; Cheng and Kong, 1993; Mak and Ng, 2005; Mak and Ng, 2008). For instance, research investigations carried out by Xu (1990) has compared the Feng Shui concepts using the Form School approach and the Hendler model, a well-known western model of site analysis. The results indicated that Feng Shui is a more powerful tool in site analysis than the Hendler model.

According to *Zang Shu* (the Book of Burial), the first surviving important literature on Form School was written by Guo Pu (276-324), there are five main theories in terms of Form, namely Qi, Wind-water, Four Emblems, Form and Direction theories (He, 1990). The Form School approach considers mountain ridges, surrounding hills, watercourses, locations and orientations as the most important terrestrial and celestial elements for human dwellings because these elements represent both terrestrial and celestial Qi. These elements comprised the basic terms of the Form School approach and were known as the "Five Feng Shui Geographical Secrets", namely, dragon, sand, water, cave and direction (Lip, 1979):

(1) ***Dragon***: means the mountain ridges to be traced, and represents the topography,
(2) ***Sand***: means the enfolding hills and soil condition, and represents the surrounding environment,
(3) ***Water***: means the flow of water through or by-passing the site,
(4) ***Cave***: or "Feng Shui Spot" means the niche position, and represents the best location,
(5) ***Direction***: means the facing direction of the site and building, and represents the orientation.

These five Feng Shui Geographical Secrets are developed into the ideal Feng Shui model that recognised by most of the Feng Shui scholars (Cheng and Kong, 1993; Yi et al., 1996) as shown in Figure 1.

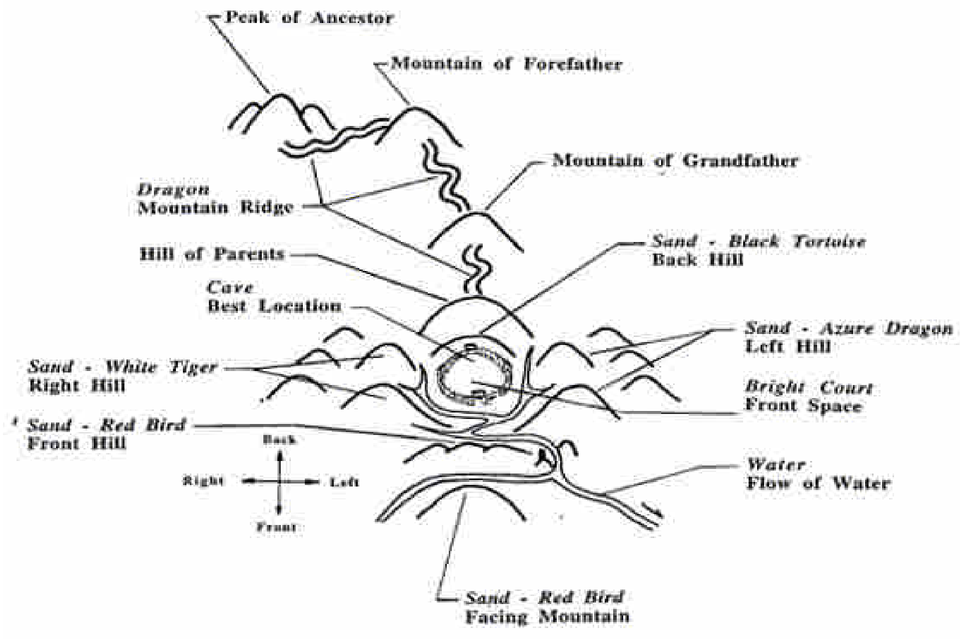


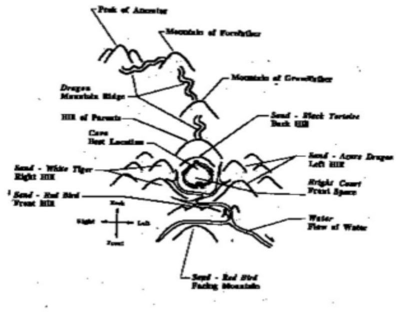
***Figure 1**: Ideal Feng Shui Model*
Source: Yi et al. (1996)

3. FOUR FUNDAMENTAL CONCEPTS OF FORM SCHOOL APPROACH

Based on the five main theories of Form School approach and the five Feng Shui Geographical Secrets, four fundamental concepts of Form School approach to Feng Shui knowledge for building design are derived: namely, the concept of the Feng Shui model, the concept of parallelism, the concept of four design modules and the concept of Feng Shui design criteria (Mak, 2004).

3.1 Concept of the Feng Shui Model

The combination of these five Feng Shui geographical elements and the four emblems (green dragon, white tiger, black tortoise and red bird as the four cardinal directions) produced a classic Feng Shui model. This model has been interpreted in diagrams of spatial organization of auspicious mountains and watercourses in most of the ancient Feng Shui literature. Many Feng Shui researchers have summarized these diagrams into a simplified diagram of a Feng Shui model as shown in Figure 1 (Shang, 1992; Cheng and Kong, 1993; Han, 1995; Yi et al., 1996; He, 1998). This diagram illustrated the relationships between the key elements of the five Feng Shui geographical secrets being considered and how dragon vein, four emblems in sand, water feature, cave and bright court, and their directions were integrated into a simplified Feng Shui model as shown in Figure 2.



The Ideal Feng Shui Model
Source: Yi et al. (1996)

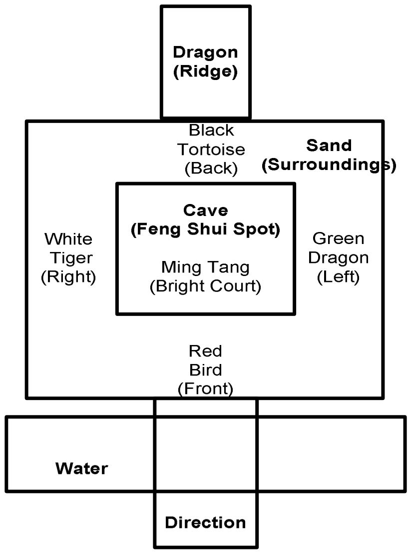
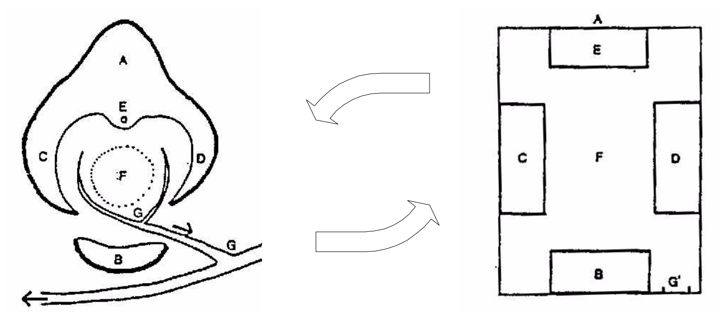


Diagram of the Feng Shui Model

***Figure 2**: The Feng Shui model*
Source: Yi et al. (1996) and Mak (2004)

3.2 Concept of Parallelism

Most Feng Shui scholars (Skinner, 1982; Lee, 1986; Xu, 1990) recognized that the theories and practices of Feng Shui work in macrocosm and microcosm. In terms of Feng Shui, a building is considered an architectural as well as a cosmic structure (Lee, 1986). Territory on earth is organizationally analogous with the four quadrants in the celestial sphere. These four quadrants are called Azure Dragon, Red Bird, White Tiger and Black Tortoise, and are commonly known as the "Four Emblems". Each of these heavenly quadrants is identified with the regions of East, South, West and North respectively. This relationship is recognized as the concept of parallelism in Feng Shui (Lee, 1986). The concept of a Feng Shui model not only applied to landscape and site selection, but it can also be applied to the interior layout of buildings. Therefore, whether it is dealing with physical or topographical elements, or housing structure, or the proportional relationships of the interior of a house, the same principles and relationships of the Feng Shui model are still applied as shown in Figure 3.

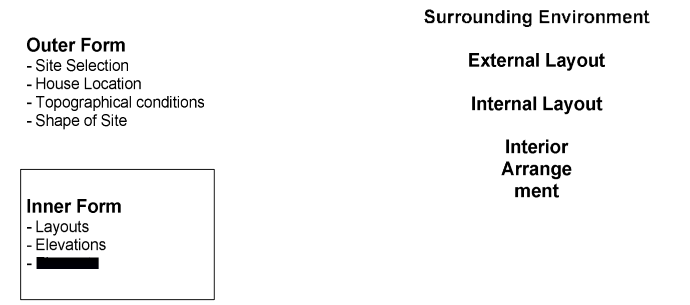


A Black Turtle
B Red Bird
C White Tiger
D Azure Dragon
E Feng Shui Spot
F Ming Tang
G Water Mouth
G' Gate

***Figure 3:** Correspondence of the Four Emblems in Nature and Architecture*
Source: Adopted from Lee (1986)

3.3 Concept of Four Design Modules

When describing the site conditions and the design of dwellings, most of the Feng Shui texts, such as *Yang Zhai Shi Shu* (Ten Books on Dwellings of Living) categorized these aspects into Outer Form and Inner Form. According to Lee (1986), the Outer Form can be identified as the location of the site, conditions that surround the site, topographical conditions of the site and the shape of the site. The Inner Form can be identified as the layout of the building, elevations of the building, and elements of building. Feng Shui scholars, Cheng and Kong (1993) explained the application of the Form School approach to the design of dwellings and proposed a further classification into four design modules: surrounding environment, external layout, internal layout and interior arrangement as shown in Figure 4.



Outer and Inner Form (Lee, 1986)   Four Design Modules (Cheng & Kong, 1993)

***Figure 4**: Four Design Modules*
Source: Mak (2004)

(1) ***Surrounding Environment*:** This aspect looks into the surrounding environment from a geographical point of view. This includes natural elements of topography, geographical features, mountains, watercourses, directions, views and man-made structures of roads and adjacent buildings.

(2) ***External Layout:*** The external layout deals with the external shape and exterior space of a building. This includes the shape of site, geometry of the building, open space, entrances, driveways, landscaping, and plants.

(3) ***Internal Layout:*** The internal layout reflects the spatial management of a building. It considers the locations and functions of rooms, circulation patterns, internal elements of structure, columns and beams, staircases, ceilings, doors and window openings (Rossbach, 1987).

(4) ***Interior Arrangement:*** The interior arrangement addresses the internal room arrangement and furniture placement. It considers the size and proportion of rooms and windows and doors. Furniture placement is a major part of interior arrangement. In practice, the bed in the bedroom, the stove in the kitchen, the desk in the office etc. have substantial effects on the use of a building (Rossbach 1987).

3.4 Concept of Feng Shui Design Criteria

Most contemporary Feng Shui scholars (Lip, 1979, 1986; Rossbach, 1984, 1987; Lee, 1986; Xu, 1990; Han, 1995; and Choy, 1999) have set up their own criteria for Feng Shui design. For instance, Lee (1986) outlined three-basic-criteria for architectural design; Xu (1990) derived a four-step landscape model to deal with land formations; Han (1995) used 24-major criteria for selection of the best location; Lip (1979, 1986) listed a set of standard rules of thumb for assessment of architectural design; Choy (1999) suggested a ten-point design criteria checklist for property selection; and Rossbach (1984, 1987) provided a set of interior design diagrams for furniture placement. Although these criteria derived from various contemporary Feng Shui scholars were presented in different formats, they all follow the principles and practice of the Form School approach. Based on these contemporary practices for Feng Shui design, 24 key criteria are identified (Table 1) and grouped according to the four design modules as shown in Figure 5.

***Table 1**: 24 Key Feng Shui Criteria for Building Design*
Source: Mak (2004)

Surrounding Environment	**External Layout**	**Internal Layout**	**Interior Arrangement**
♦ Topography	♦ Shape of Site	♦ Layout	♦ Door Openings
♦ Front of Site	♦ Entrance	♦ Doors	♦ Bedroom
♦ Rear of Site	♦ Shape of Building	♦ Windows	♦ Kitchen
♦ Sides of Site	♦ Orientation	♦ Shape of Rooms	♦ Living Room
♦ Street Location	♦ Trees	♦ Staircase	♦ Bathroom
♦ Water View	♦ Pond	♦ Ceiling	
♦ Wind Direction			

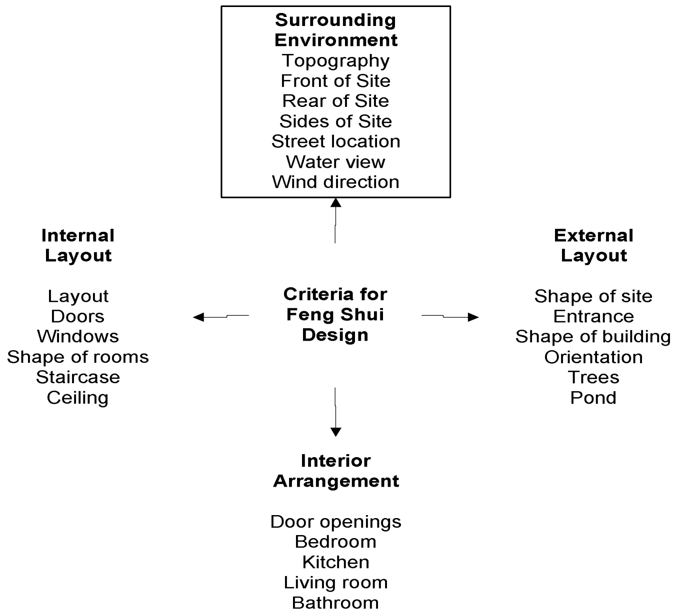


***Figure 5**: Feng Shui Criteria Grouped in Four Design Modules*
Source: Mak (2004)

4. HIERARCHICAL STRUCTURE OF FENG SHUI KNOWLEDGE

Based on these four fundamental concepts of the Form School approach, an overall view of the Form School approach was provided. It is necessary to formulate a suitable process to integrate the four fundamental concepts of Feng Shui knowledge. It is recognised that a concept hierarchy approach provides a powerful way to represent structural knowledge (Tam, 1993).

Using a concept hierarchy, the relationship between each piece of data can be expressed and presented allowing the data stored in the database with abstract term (Lee et al., 1997). Concept hierarchy is used to organize factual domain knowledge and symbolic structural knowledge in the form of a generalization hierarchy. It is a common approach to utilize concept hierarchy for organizing structural knowledge and constructing the knowledge base because of its efficient mechanism to store and generalize a large body of interrelated concepts (Tam, 1993).

When constructing a concept hierarchy of the Feng Shui knowledge, the four fundamental concepts are represented in a format of hierarchy and are then integrated to form a skeletal structure of the hierarchy of the Feng Shui knowledge as shown in Figure 6.

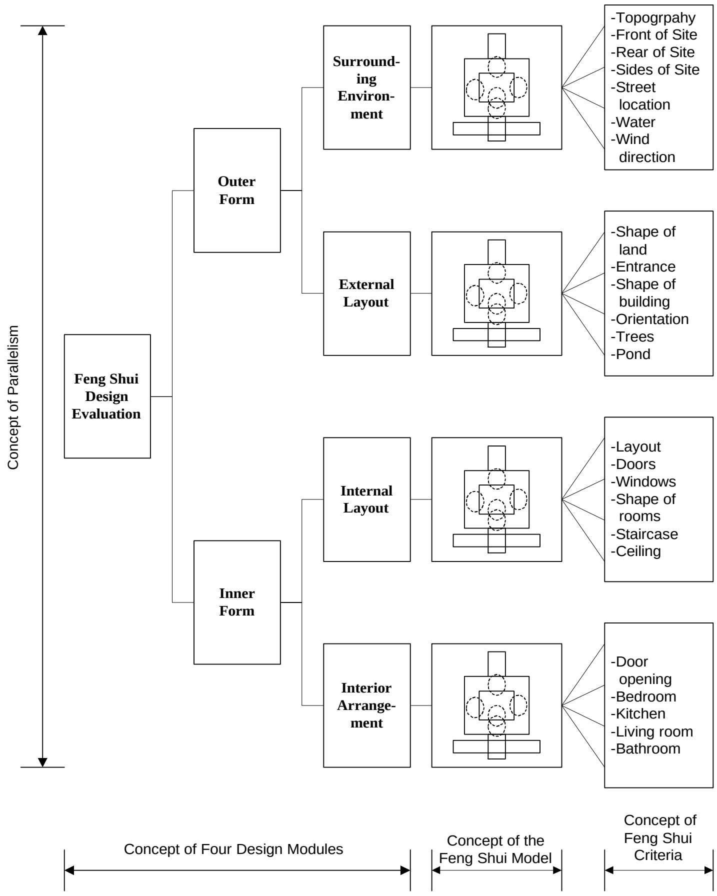


***Figure 6**: Hierarchical Structure of Feng Shui Knowledge*
Source: Mak et al. (2005)

A questionnaire survey of architects practiced in Sydney and Hong Kong was used to evaluate the four fundamental concepts and the developed hierarchical structure of the Form School approach. These two cities are selected to explore any divergences resulting from different cultural, educational and geographical background. The results of the survey show that these fundamental concepts and the hierarchical structure are corresponding to the current work practices and knowledge of both Eastern (Hong Kong) and Western (Sydney) architects (Mak, 2004). Overall, there was very strong correlation between both groups of architects in Sydney and Hong Kong notwithstanding the fact that they have very different cultural, educational and geographical backgrounds (Mak and Ng, 2005).

5. CONCLUSIONS

Building design is a very complex process, and integrated design approach emphasizes the development of a holistic design. These characteristics are similar to Chinese philosophy of direct insight into the nature and the principles and practices of Feng Shui as applied in ancient Chinese architecture. In particular, the Form School provided a holistic approach that allows integrated components and elements to be considered for the built environment.

Although the principles and practices of the Form School approach provided a broad understanding of the Feng Shui knowledge, a systematic development of the four fundamental concepts and a hierarchical structure of Feng Shui knowledge have never been established. This paper provides a detail understanding of the Form School approach and to create a structured framework for building design, and may help improving the awareness and usage of this ancient Chinese wisdom for integrated design.

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Workshops as practicum's to improve integration and knowledge exchange in collaborative design

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Ad den Otter[2]
Wim Zeiler[3]

ABSTRACT

The cooperation between the various disciplines interacting in an architectural design process is often inadequate or lacking. This is due to the growing complexity of building design processes involving many experts from different disciplines, having a different knowledge background, view and approach to solutions for design and construction. This lack of collaboration is usually shown by the next aspects; a lack of integration in the team, knowledge gaps between design and construction, failing flows of information and communication and feedback between designers and practitioners. In order to increase the potential of creating better integral design concepts, practitioners tend to use support tools. A design management approach to support design teams integrally in order to improve collaboration and affecting communication needs to focus better on the process aspects of conceptual design. Such a design management approach should easily link all necessary information and knowledge of the involved disciplines (architects, engineers, contractors).

To that account in this paper, a support tool is presented that stimulates members of design teams to use collectively a specific method for collaborative design that incorporates the characteristics of an integrated product model. The aim of the management intervention is to support design activities by the use of a framework for the design process to structure information and knowledge exchange between and with commitment of all participants to optimize design solutions. This method, the so called Morphological Overviews, is based on Morphological Charts. The concept will be explained on its functioning and be discussed by the results and insights gained through a series of Workshops executed in the period 2005-2008 with practitioners from the Dutch Construction Industry. Also is discussed how partly, elements of this approach can be used in architectural design management. The paper finalizes with conclusions and recommendations for further research.

KEYWORDS
Workshops, integral approach, knowledge exchange, collaborative design teams

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1. INTRODUCTION

A lack of innovative designs in the Dutch Building industry can be observed in the designing of roofs. For the purpose of this research project a design is defined as a basic scheme or graphic representation that affects and controls function or development for a subject that has to be constructed or manufactured. Innovative designs can be defined as designs that show smart improvements in design solution by using experiences, and experiments or improvement actions for the design that affects its purpose and functioning greatly. Professional parties indicate that such a lack of innovation is caused by sub-optimal interaction between solutions and application in design practice of traditional roof design compared to innovative roofs [EURACTIVE ROOF-er 2005]. Cooperation between the various disciplines interacting in an architectural design team often is inadequate or lacking due to knowledge gaps between design and construction, failing communication and feedback between designers and practitioners and insufficient integration of such teams. This is due to the growing complexity of architectural designs, involving a growing number of experts from different disciplines, having a different knowledge background, view and approach to design and construction. During the design process, teams generate new knowledge by exchange and develop information about the design to be produced. Such a design process for the design of a (new) product might also be called a Collaborative Design [Bento et al. 2004]. Within such a setting, actors like architects and roofers, differ in cultural backgrounds, their way of working, and have a different motivation of collaboration and geographical conditions [Korbijn 1999]. Architect and Roofer collaborating on the roof design, acting as representatives of their discipline better can be described and defined by their competences that is expressed in their design activities as Dorst [1997] explains. Due to interdependency between the actors [Latour 1987] knowledge exchange and sharing is needed that is showed in their interpersonal communication using preferred communication tools [Emmitt et al. 2008].

An Integral Design management approach to support the designers in such design teams to improve their collaboration has to focus on the process of conceptual design in order to increase the potential of creating higher transparent Integral Designs (product level). Such a design approach should easily link all suitable information and knowledge of all the involved disciplines (architects, engineers, contractors). Due to the fact that the information and knowledge comes from various disciplines as described above, the information and knowledge collected, shows mostly several different characteristics, related to various levels of abstraction. Levels of abstraction means the decomposition of information into levels of increasing detail, where each level is used to define the entities in the level above. In the hierarchical way we can define the problem definition level, the working principle level, the detail design level and the realisation level. For each domain of industry the infill of these abstraction levels will be different [Kroonenberg 1986]. Representations, are methods which with different disciplines work, such as material systems, sketches and information technologies. External representations are the transformation of internal thought processes of people on cognitive level [Lawson 1994; Wiegeraad 1999; Reymen 2001] and expressed using some kind of interpersonal communication, together they are cognitive achievements by these people. Different disciplines use different kind of representations (concepts, terms, notations or language) [Brereton 1998]. An optimal support tool will affect optimum design proposals which can combine the different levels of abstraction with different kind of representations.

For these reason this research focuses to the knowledge sharing and exchange on cognitive level of design team members. It is assumed that architectural design teams using a Design Method that incorporates the characteristics of the integrated product, easily might lead to better optimized and smart designs. The aim of introducing a specific Design Method is to support team members within this highly complex process (Collaborative Design) by means of a framework for the design activities to structure the information and knowledge exchange.

The Design Method presented to architectural design teams is the so called, Morphological Overview. The method is derived from the Morphological Charts developed by Zwicky and Norris (1967). General morphological analysis was developed by Fritz Zwicky [Zwicky & Wilson 1967] as a method for identifying and investigating the total set of possible relationships or configurations contained in a given complex problem [Ritchey 2002]. Morphology provides a structure to give an overview of the considered functions and aspects and their solution alternatives. Transforming the client's brief into characteristics for input and output (aspects) and formulation of the different relations between input and output (functions) to fulfil, leads to the construction of a Morphological Overview. The overview of possibilities from all disciplines involved in the team (such as Architects and Roofers) is based on interpretations of the design tasks and the representation of specific knowledge that different disciplines use through this interpretation, represented by the introduced functions, aspects and solutions. The 'completeness of the design' therefore can be viewed as an indication of how complete the different kinds of knowledge from each discipline is used and as an indication for the level of integration.

To be able to observe the disciplines involved in design in a relaxed, transparent and clear way without big brother effects [Orwell 1984], a practical setting is needed. In such a setting human subjects can be studied similar to a laboratory setting [Yin 2003; Frey et al. 2006]. However, generalizing the results from experiments need thorough care because the quasi-laboratory setting [Yin 2003] need to simulate all real-world characteristics. The practicum as proposed by Schön [Schön 1987] creates a setting as ' a virtual world, relatively free of the pressures, distractions, and risks of the real one, to which, nevertheless, it refers.' [Schön 1987, p 14]. In Schön's practicum a person or a team of persons has to carry out the design. A practicum can asses a design method and the degree to which it fits human cognitive and psychological attributes [Frey et al. 2006]. The workshops used are designed as a specific kind of practicum. It is represented as a self-evident way of working for designers that occurs both in practice and during their education. Such workshops provides a suitable environment for collaborative design and doing observations. Besides full design team line-up workshops provides a number of advantages, regarding standard practice situations, and also retaining practice-like characteristics. Another advantage is the gathering of a large number of design professionals, the repetition of an assignment and the observation and comparison of the design process and the design that different design teams produce. By monitoring and comparing the knowledge exchange and knowledge development in various design situations between the Architect and the Roofer, that do or do not use the Morphological Overviews, the occurrence of knowledge gaps can be analyzed and what effects the use of morphological overviews have on the actors and the design produced. Earlier studies with a wider view in the UK [Latham 1995; Egan 1997, 2002] came to proposals for better organizing and training design and construction teams to accelerate the design process. Research on Integral Design in Dutch practice with professionals, both for development and evaluation, is ongoing from the year 2000 [Quanjel et al. 2003] The workshop as presented in this paper might contribute substantially to this research providing insight into collaborative design between specific disciplines (Architects and Roofers) on cognitive level, the effects on the design product and the use of a specific design method, the Morphological Overview. In the next paragraphs the relation between the workshops and improvement of integration and knowledge- exchange and development between a designer and contractor.

2. WORKSHOPS RELATED TO KNOWLEDGE- AND DESIGN MANAGEMENT

By means of Collaborative Design meetings, team members are able to improve their own work, share knowledge and understand existing artefact or design state from collaborative point of view. Each session uses the individual and collective design knowledge that was generated as a resource to build an argument. During such a design process, a team collectively can easily transform tacit knowledge into an explicit form. Also aspects related to the specific design task are made transparent to each other. Structuring and questioning the explicit made knowledge by the team should result in building the much needed support for knowledge development and management of the design. Structuring the design is related to the rational problem solving-part of the design as Simon [1998] argues, and that questions the design as a part of the reflection in action-part [Schön 1987]. Both actions can be seen as part of the design activity of the design, the third part of describing the design [Dorst 1997]. However we are most interested in the design as '*a basic scheme or graphic representation that affects and controls function or development for a subject that has to be constructed or manufactured'* that is represented by the explicit knowledge of each individual team member (Architect and Roofer). This knowledge is the result of transformation of the tacit knowledge of these team members derived by the use of Morphological Overviews in the setting of the workshop.

To identify the various types of knowledge of Architects and Roofers we take a closer look to the typology of knowledge as discriminated by van Aken [2005]. He discriminates between object- and realization-knowledge as part of the process-knowledge. This process knowledge through collaboration will link the needed requirements for innovative designs; the design- or object knowledge and the building- or realization knowledge [Aken, v. 2005]. The types of knowledge stated, are communicated between Architect and Roofer (both having another educational background and differ largely in competences and skills) through different kinds of representation [Brereton 1998]. Object knowledge can be defined as knowledge on the characteristics and properties of artefacts and their materials. Finally, the third type of knowledge, realization knowledge, can be identified as knowledge on the various physical processes to be used to realize designed artefacts [Aken, v. 2005]. By using the three types of explicit knowledge we need to find a way to extract practical information about each type related to the different disciplines. For that purpose we used the Competence-Profiles of the Architects and Roofers from the Professional Sector Organisations. Through these Competence Profiles we qualified the process-, design- and realization-knowledge of the different disciplines in the setting of Collaborative Design. Only the Architects and Roofers with these competence-profiles can give the information, in the specific setting, about how the knowledge exchange and development for innovative roof-designs, can evolve. All aspects related to the relation of the knowledge gap and designs for innovative roofs could be described in this way. The design situation of Collaborative Design in practice is described by the set-up of the Workshop. The design activities for Integral Design, as both rational and reflective, for structuring and develop the object- and realization-knowledge, are identified through the use and effects of the Morphological Overviews. Through a specific setting of the Workshop we can gather information about Knowledge Management (exchange and development) related to design task for innovative roofs and – in further perspective –use this Workshop-setting as a tool for Design

Management within the setting of Collaborative Design. An Integral Approach on the development of the Workshops was used; through different viewpoints on the setting and set-up of the Workshop we could define the optimal Workshop-setting. Two main aspects related to the Workshop-setting were insight into the design-process – exchange and develop specific knowledge related to the design task – and the influence of MO as a Design Method / support tool. In the next paragraph the development of the workshop-setting is demonstrated and related to Knowledge – and Design-Management.

3. DEVELOPMENT OF THE WORKSHOPS AND DESIGN MANAGEMENT

For the Workshop-development three different viewpoints were chosen. The first view (Figure 1.: WS 03) focuses on collaborative design-teams in an in-company-setting and the use on the support tool Morphological Overviews. The second view (Figure 1.: WS 04) shows the step to an 'open setting with free-attending Architects and Roofers for collaborative design-teams, using two different support tools Morphological Overviews and a web-based Database. This set-up is compared with the third view; the setting with free-attending Architects and Roofers using only Morphological Overviews (Figure 1.: WS 05).

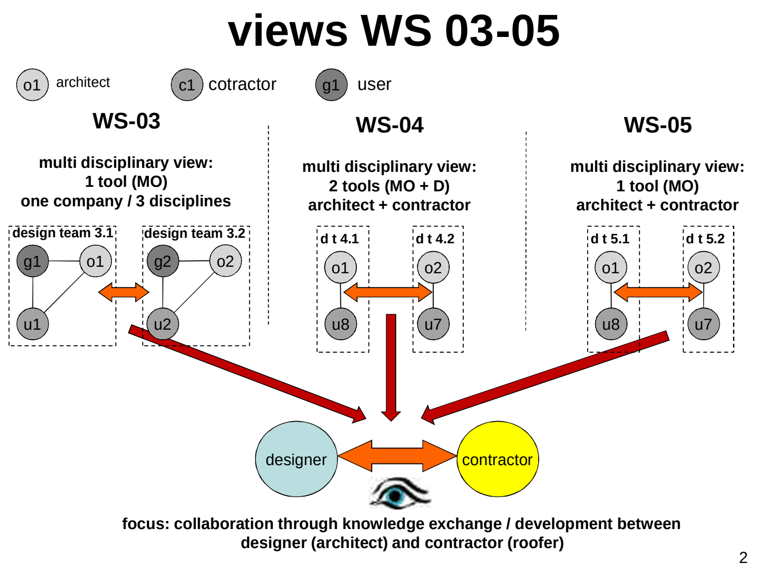

***Figure 1:** Different views on the same topic with professionals; collaboration between architect (o1-oX) and contractor (c1-cX) by professionals. WS 03: with multidisciplinary view with users with in-company use of Morphological Overviews (MO), comparing design team dt3.1 and 3.2., WS 04: comparing multidisciplinary teams dt 4.1 and dt 4.2 with the use of two different design methods(MO and Database D).*
WS 05: comparing multidisciplinary teams dt 5.1 and dt 5.2 with and without using the Morphological Overviews (MO).

All participants had to have a specific Competence Profile in order to attend the Workshop to give an optimal contribution related to specific knowledge and skills as shown in the earlier paragraphs. This was the only selection criteria made, all participants submitted to the Workshop freely, all influencing effects the observers present might cause, were carefully avoided. The researchers organized and managed the workshops, although during the workshops the main role was only in the introduction. The researchers where assisted by post-doc students of Architectural Management for practical aspects as well as monitoring. One researcher was also the workshop leader. Three analyzing methods were used by the researchers for reflection on the workshop-setting; discussion between the workshop leader with the participants immediately after the workshop-session. A standard questionnaire that is used for all workshops with questions about set-up and experience of the workshop and the use of the Morphological Overviews. .The questionnaire had to be filled in immediately after the workshop. Six months after the workshop took place the participants were contacted and filled in the same questionnaire. The third method used was the evaluation from the researcher related to practical aspects for organizing the workshop and the optimal setting for monitoring and analyzing the results; the explicit knowledge exchange and knowledge development related to the use of Morphological Overviews. Practical aspects of organizing used are; the amount of time for the workshop per design-item as well as the amount of items itself, avoiding research influence on the workshop, promotion for submitting the workshop and efficient location. For monitoring and analyzing related to the workshop setting two aspects are of main importance; a) the comparison of design teams that used the Morphological Overviews in a 'neutral way and the ones that did not, b) participants with the right Competence P and c) different ways of monitoring during the workshops. For all workshops video (sound and vision) are used, photographs of the group and group-results in a regular time-scheme. Trainees in Architectural Management functioned as observers of the sessions. They were introduced as working on one of their practicum-courses to make a critical analysis of design-teams. In the next part, shortly the development per workshop is described related to the described aspects. The monitoring of the Architectural Management Trainees was global on collaboration between the participants. They were used as general reflection on the setting and collaboration of the different workshop-settings, and part of the triangulation [Yin, 2003] Lessons learned from the different workshops are also given as well as the outcome of the questionnaires as filled in by the participants focussing on the reflection after six months.

The first view was the limited view from professionals working within an engineering / contractor company for the high-technology roofing-industry (Brakel & Atmos); the project situation inside a company is without the variables and influences of the multidisciplinary team in the projects outside. This specific view from the engineers / constructors was used to reflect on the project situation outside. Both individuals as internal teams were used to work traditionally and with the use of MO. The feedback used is that of the needs of knowledge with Roofers from Architects and visa versa, coupled on improvement of the workshop-setting with architects. In WS 03, 25 professionals were participating. Positive aspects of this setting were the guaranteed amount of participants as well as their Competence Profiles. Also publicity was no problem as well as the location because the company was positive about this initiative. This can also be seen as a negative point related to the probable influence on the research-results. Difficulty was also that there was only one big room available for the workshop; this made it problematic to let teams working simultaneously on a design task as well as parallel with and without Morphological Overviews without influencing each other. This made also the monitoring problematic. Other difficulty related to comparing the outcomes were that, beside of designers and contractors, also clients / users were part of the design-teams. Now knowledge-interaction between designer and contractor could not be observed and analyzed clearly. Time items were seen as problematic by the participants.

The second view was inside the project-context with Architects and Roofers. Output of workshop WS 03 showed clearly that focussing on Architect and Roofer, without other participants, was the best for monitoring purposes in the scientific context.. In both WS 04 and WS 05 the BNA (Royal Dutch Organization of Architects) was involved and two Dutch Roofer-organizations: 'Het Hellend Dak' and 'Vebidak'. This participation guaranteed that participants had the right Competence Profiles-check and that publicity was not connected to the researcher. Both workshops were divided in two parts; an individual part and a team work part, this provided the possibility to compare the knowledge of the individual discipline with the situation of those disciplines in the collaborative team-setting. In WS 04, eighteen participants used the tools from the start, after an introduction, to determine which of the different design methods could be more effective during the workshop. The two different design methods used are the MO and a within the EURACTIVE ROOFer developed database (D). Beside of the positive aspects already mentioned also the location was more optimal than in WS 03; we used a beautiful congress-resort with separate rooms available, but still a bit too small for the group-setting. Negative lessons learned were the time-pressure due to the fact that the participants had too many sessions with two different design methods which were new to them. Focussing on just one new design method was therefore necessary for the follow up. Another negative aspect was caused by the set up only to work directly with the Morphological Overview and Database; due to this setting comparing situation with and without using the methods was not possible as well as that for the participants no reflection – second learning loop – was possible.

In the third workshop (WS 05) by means of parallel sessions of teams partly using the MO provided the opportunity to compare the design situations and comparing the knowledge sharing and development related to the use of Morphological Overviews. In this workshop 12 professional Architects and Roofers were participating, a rather small group (but sufficient for the scientific comparable amount needed). There was now also more time between the several design sessions. The chosen location was more central geographically and had more space for the different parallel sessions without influencing each other. One of the problems which could not be solved was research influence by the researcher; the organisation and publicity was done mainly by the researcher himself. The time-aspect in relationship to the second-loop-learning by reflection on the use of the Morphological Overviews could also not be fulfilled. Through this workshop and the lessons learned from the previous workshops we found the set up where we can compare the different knowledge-types and explicit knowledge used, exchanged and developed by roofers and architects. methods, individual and in teams.

Another indication for viewing the workshop-setting as proposed was the questionnaire-format (see Table 1.). To avoid influences on the participants by the researchers and observers present in the workshops only the response on the questionnaires after six months was evaluated. Overall the tendency of the ratings for the workshop as well as the use of the Morphological Overview was positive for all workshops, see Question Q4 in Table 1. Critical aspect of time related to the session (Table 1.; Question Q3) which were rated bad in the first two workshops where rated positive in the last workshop-setting WS 05; Architects 3,0 (4 out of 6) and Roofers 2,6 (4 out of 6). The ratings if it is useful to stimulate Morphological Overviews through Workshops and the future expectations seems more critical for Architects than for Roofers (see Q11 and Q12, Table 1.), but overall the ratings have a positive tendency. After evaluating the results of the former workshops with students and professionals, was to arrange the definitive workshop-setting (see figure 2; workshop WS D01). To give the participants, as part of the learning cycle, time to reflect on the use of the Morphological Overviews and the Workshop-setting the workshop is divided in two parts; there is one week between the first part (1 and 2) and second part (3, 4 and 5). For generalization of the results parallel to the setting the workshop-setting incorporates teams with Architect (figure 2: o1-oX) and Roofer (figure 4.; r1-rX), as well as Architect and Installer (figure 2.; u1-Ux). First part of the workshop has two steps; step one working individually without the support tool, this to get insight in the specific discipline knowledge related to the Competence Profiles and found functions, aspects and solutions (a-io1 – a-ioX, a-iu1 – a-iuX).

Table 1. *Overview of average ratings questionnaire-format for all workshops WS 03,WS 04 and WS 05; average ratings for questionnaires after 6 months related to response are evaluated.*

overview questionnaires WS 03-05

A = Architect / R = Roofer Rating from 1 - 5	Q1 How important use MO to your practice	Q2 How do you rate the relationship Integral Design and Methodical approach	Q3 How did you experience amount of information and time	Q4 What rate for the Workshop set-up	Q5 What rate for the speakers	Q8 Use of MO - general	Q9 Communication and MO	Q10 Designprocess and MO	Q11 Usefull to stimulate use MO within practice	Q12 Expectation future use of MO
WS03 - A average direct / 9 out of 9 / 100%	2,7	3,7	1,7	2,7	3,0	3,3	3,2	3,7	3,2	1,8
WS03 - A average after 6 months / 8 out of 9 / 88,9%	**2,6**	**3,2**	**1,5**	**3,0**		**3,0**	**3,0**	**3,1**	**3,1**	**2,0**
WS03 - R average direct / 8 out of 8 / 100%	3,7	4,0	2,0	3,7	4,0	3,7	4,0	4,0	4,3	3,4
WS03 - R average after 6 months / 8 out of 8 / 100%	**3,5**	**3,7**	**1,8**	**3,5**		**3,5**	**3,6**	**3,6**	**3,9**	**3,4**
WS04 - A average direct / 8 out of 9 / 88,9%	3,8	3,0	1,7	3,8	3,6	3,4	3,6	3,6	2,2	2,5
WS04 - A average after 6 months / 6 out of 9 / 66,7%	**2,7**	**2,7**	**1,5**	**3,3**		**2,6**	**3,0**	**3,0**	**2,7**	**2,5**
WS04 - R average direct / 9 out of 9 / 100%	2,3	4,0	1,6	4,0	4,0	3,6	4,0	3,8	4,0	3,4
WS04 - R average after 6 months / 6 out of 9 / 66,7%	**2,3**	**2,7**	**1,5**	**3,5**		**3,0**	**3,0**	**3,0**	**3,5**	**3,5**
WS05 - A average direct / 6 out of 6 / 100%	2,8	4,2	3,0	3,8	3,0	3,2	3,4	3,5	3,0	3,0
WS05 - A average after 6 months / 4 out of 6 / 66,7%	**3,0**	**2,3**	**3,0**	**3,5**		**3,0**	**3,3**	**3,0**	**2,7**	**2,7**
WS05 - R average direct / 5 out of 6 / 83,3%	4,0	4,0	2,7	4,0	3,1	3,7	3,7	3,9	3,8	3,5
WS05 - R average after 6 months / 4 out of 6 / 66,7%	**3,0**	**2,4**	**2,6**	**3,7**		**3,2**	**3,6**	**3,0**	**3,3**	**3,6**

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The second step implied the working in teams (dt 2.1, dt 2.2) parallel with and without Morphological Overviews (MO). After one week the same participants come together. Now the teams are changed so that there is no influence on the group-learning process; team dt 3.2 formally working with Morphological Overviews (MO) is now working in a traditional setting were team dt. 3.1 is now working for the first time with Morphological Overviews (MO). Results d-id-3.2 and d-id-3.1 can be compared as well within this step as with step 2 (b-id-2.1 and b-id-2.2).

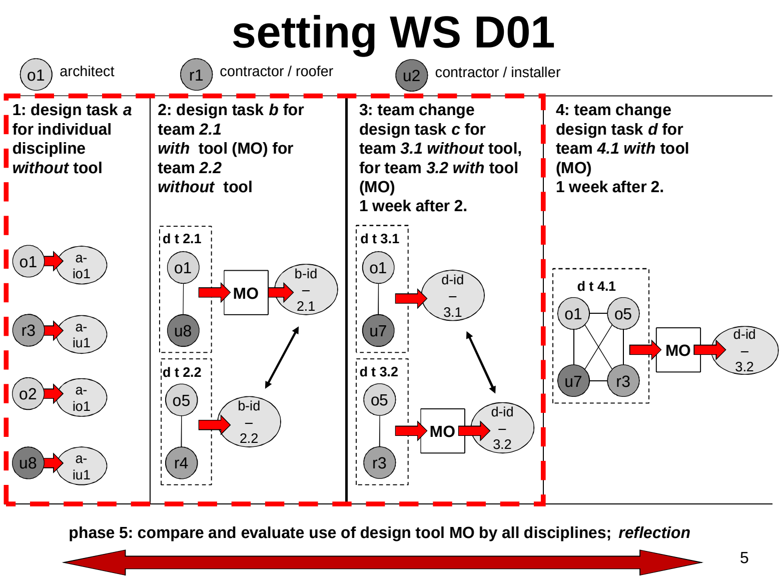

Figure 2: *The Workshop set-up as developed to determine the influence of MO as Design Method (Knowledge Management) and Collaborative Design as process tool (Design Management).*

Using the second-loop-learning effects method as Agrys [1999] described, finally the teams (dt 4.1 – dt 4.X) are working all for the second time with Morphological Overviews as a support tool and can reflect on this as well as on the workshop-setting itself. Due to the parallel design-sessions in separate rooms comparison of the monitoring situation is optimized. By experimenting with the monitoring tools the final setting could be fixed; video-recordings of each design-team-session, photographs in a regular time-schedule of the produced design-drawings and general assessments and evaluation by Architectural Design Management students. The organization of the Workshop by Professional Organizations a more research-neutral setting is possible as well as a better check on the Competence-Profiles of the participants. Also publicity and organization of a suitable location is optimized through the use of Professional Organization.

4. DISCUSSION AND CONCLUSION

The workshops executed in the past years in the setting as explained, are analyzed by the researchers and evaluated with the participants using structured Questionnaires. The comparison of the answers of the questionnaires showed that the workshops were effective to the opinion of the participants, also after six months. The outcomes of the questionnaires compared to the monitoring results show that this 'tool' is an effective setting that encourages designers and practitioners for active participating in Collaborative Design. The use of the M.O's. were rated positive by the participants with a positive view on the usefulness of the workshops, as shown in Table 1.

The final workshop-setting (figure 3 WS-D01) developed is called the Collaborative Design Workshop. The tool proved to provide the right conditions for researching the effects of the use of Morphological Overviews to collaborative design. Throughout 2009-2010 three workshop sessions for Architects, Installers and Roofers will be organized, with approximately 75 professionals within the Permanent Professional Education Program. The organizing of these workshops is a first step in stimulating Design and Knowledge Management within a multidisciplinary, integrated setting.. All effects will be evaluated to optimize the workshop setting and the use of Morphological Overviews. The outcomes of the final workshops executed during 2009-2010 will be compared on its functioning and expectations: improving the design output and stimulating collaborative working between the concerned designers. The results will also be compared with the results out of earlier workshops on similarities and differences. The observations, design output and opinions of the participants will be used to develop conclusions for the research project and the use of this workshop model as an effective tool for implementing a new approach in collaboration leading to effective exchange of design knowledge and information. To the opinion of the researches further research is needed to Collaborative Design on the other abstract level: user-client is necessary to optimize Collaborative Design and the role of the contractor in a Design Team (Architect, Structural Engineer, Building Physics Adviser and Building Services Adviser). The addition of last aspect is related to another PhD-research executed by Savanovič (2007).

5. AKNOWLEDGMENTS

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Challenges in negotiating trade-offs in pre-design briefing of healthcare projects

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ABSTRACT

Pre-design stages are fundamentally formative to the project's whole life cycle. This is where key design decisions affecting most of the long-term characteristics of a building are made. This paper is part of a PhD research project in progress. It is motivated by issues surrounding UK's national healthcare provider, the National Health Service's (NHS) recent introduction of public and patient involvement initiatives in the planning of healthcare buildings. Consequently, a wide variety of people is now involved in the building design process which was originally undertaken by a small group. Usually, multiple issues pertaining to the several needs and requirements raised by the large number of participants must be addressed and resolved early for design to commence and be successful. Some of these issues may sometimes be conflicting. Moreover, it has been noted that when there is more than one incompatible requirement, trade-offs are inevitable. In a funding-constrained decision-making environment, engaging various stakeholders in the explicit trade-off between such issues like required functionality, aesthetics and timely completion, without compromising overall system objectives is critical. Literature shows that, establishing a sound group process for negotiating and making requirement trade-offs results in more complete requirements in the early stages and enables a shared vision throughout the project's life cycle. In this paper, we report an insight into early multiple stakeholder participation-induced challenges in both pre-design process as well as in negotiating trade-offs. It is based on preliminary interviews with an experienced professional involved in pre-design briefing stages of healthcare projects. The aim of the investigation was to inform the question of how to better manage trade-offs in the briefing processes involving multiple stakeholder groups. Interview results highlight that the role of effective communication in successful negotiation of requirement trade-offs cannot be over-emphasized. The paper concludes by suggesting the application of Principled Negotiation as a structured way for achieving a successful outcome in the negotiation process.

Key words: *Negotiation; Pre-design briefing; Stakeholders; Trade-offs*

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1. INTRODUCTION

1.1 Background

This paper is motivated by multiple stakeholder involvement in the planning and delivery of National Health Service (NHS) healthcare construction projects in the UK. It aims to highlight pre-design process challenges resulting from recent policy changes initiated by the Department of Health which imply that all stakeholders must be involved in the planning of NHS services that affect them. Introduction of such initiatives as "*Patient and Public Involvement" (PPI),* (DH 2008a) and '*Strengthening Accountability'* (DH 2003) targets improved service delivery by involving and engaging with staff, patients and the public in service planning and consequently in the design better quality healthcare facilities.

Furthermore, NHS Trusts are now operating in a more consumer-driven healthcare market. Agendas for healthcare built environments are specifically being developed around the aspects of *consumerism, design quality* and *sustainability* (PCC, 2008). In particular, NHS' *design quality agenda* is related to the increasing awareness of the linkage between design of the physical environment and patient recovery (Lawson and Phiri, 2003), as well as, its linkage to work performance and job satisfaction of clinical staff (Ulrich *et al*., 2000). Both the *consumerism* and *design* quality agendas affect healthcare facility planning and design strategies which must now reflect all the individual patient and staff needs and requirements. However, this is complicated by the likelihood that these differing stakeholders will have diverse interests and value different aspects of the built health environment, some of which might even conflict. Moreover all this is within limited funding resources. A question arising therefore is, whose needs and requirements will be captured and how will all this diversity be reconciled in defining the design criteria?

The pre-design stage (stage A of the RIBA plan of work, 2007), particularly, briefing of construction projects has become central to design management over the last decades (Smith et al., 2001). Over the years, studies have shown the importance of this stage as one in which the making of critical decisions takes place (e.g. Duerk, 1993). Pre-design decisions are critical because they affect the success or failure of the ensuing phases of the whole lifecycle (Kelly, 2002). Moreover, Barton and Pretorius (2004) have noted that most economic decision-making, public or private, concerns the application of limited resources. Accordingly, Best and de Valence (1999) noted that for the large sums of money they invest in building procurement, clients such as UK's NHS, who commission the design and construction of buildings, hope to maximise the value they obtain. However, Earl and Clift (1999) recognized that, increasingly, decision-makers are being faced by complex investment decisions created and made emotive by diverse stakeholder expectations.

In addition, successful completion of construction projects is dependent on meeting the expectations of stakeholders throughout the project life cycle (Cleland, 1995). In addition, when a decision-making situation involves multiple stakeholders, each with different values and expectations, the final decision is generally an interaction between their individual preferences (Alencar and Almeida, 2008). Likewise, in the usual case where financial resources are limited, decision-making may involve trade-offs between their different values and preferences. But in such a decision-making environment, engaging in the explicit trade-off between such issues such as required functionality, aesthetics and timely completion, without compromising overall system objectives is critical. In this case, top-level decision-makers are faced with discrete decision options each with uncertain consequence distribution among the stakeholders (Rosqvist, 2003). Establishing a sound group process for negotiating and making requirement trade-offs may result in more complete requirements in the early stages as well as enable a shared vision throughout the project's life cycle.

This paper is part of a current PhD research project. The research theme of which the paper is part is about achieving better Whole Life Value of healthcare facilities through improved briefing and early decision-making. This paper investigates the challenges that exist in managing a healthcare planning exercise in which stakeholders are actively involved in the pre-design decision-making. The identified challenges are based on literature and preliminary interviews with an experienced individual involved in pre-design briefing stages of healthcare projects. Emphasis is on negotiation as a process for reaching consensus in group decision-making. This focus is based on the premise that "the long-term performance of any construction and its ability to satisfy stakeholder requirements depends on the decisions made and on the care taken by decision makers in stakeholder communication" (Olander and Landin 2008: 554).

2.0 LITERATURE

2.1 Group Problem Solving

The cost of construction, operation and maintenance of buildings is very high. Therefore, it is important that the right decisions or choices are made at the right time. Currently, a capital paradigm dominates the pre-project stage, and is the main influence on the structure as well as sequence of analysis, considerations and decisions in construction projects (Woodhead, 2000). However, a new building construction paradigm is emerging. Bourke et al. (2005) note that this new paradigm embodies the need to make decisions based on whole life value thereby requiring an optimum balance of stakeholders' aspirations, needs and requirements, and whole life costs. Furthermore, it encompasses economic, social and environmental aspects associated with design, construction, operation, and decommissioning, (or where appropriate the re-use) of the asset or its constituent materials at the end of its useful life.

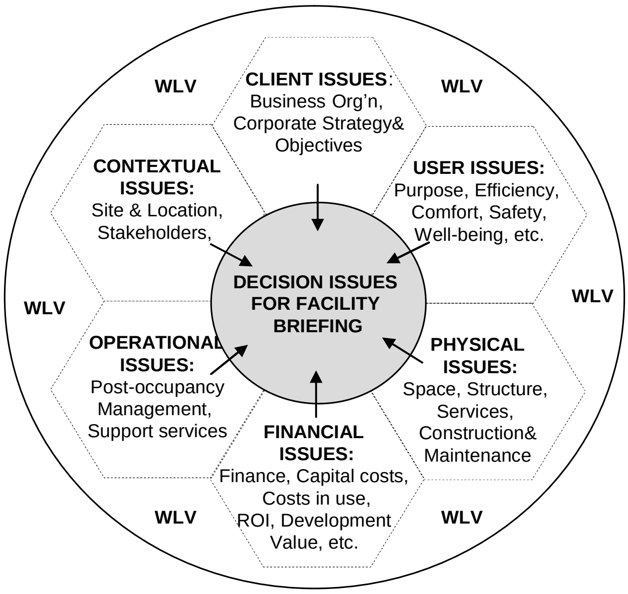

***Figure 1**: Decision issues for facility briefing*

The whole life value approach entails considering a broad range of issues that may be difficult to achieve satisfactorily. Figure 1 is an example of a range of issues that usually influence decision making during facility briefing (Nutt, 1993; Woodhead, 2000; Standing, 2001). When these issues are directly captured through engagement with several stakeholders, their expectations are raised and consequently this increases pressure on the team to deliver. Therefore, in seeking a solution, it is advisable that decisions are made not in favour of any one criteria or with the intention to maximise value for a lone stakeholder group. Rather, decision-making should be such that an optimal solution is targeted. Negotiating issues within limited funding requires amicable trading-off of issues without loss of trust in the process.

2.2 The client organisation and stakeholders

Most construction organisations consider the client to be a well defined entity with very clear and well-defined value parameters (Bertelsen and Emmitt, 2005). However, lately, it is recognised that a client is not necessarily one single point of contact. In fact for organisations like the NHS, clients are often multi-faceted in nature, comprising several diverse interest groups or stakeholders (Boyd and Chinyio, 2006), whose objectives and expectations differ, and may well be in conflict (Green, 1996). For a project to be successful, value issues of the multiple stakeholders have got to be captured, accounted for and incorporated within pre-design and later followed through during design decision-making. Therefore, by recognising and identifying all the groups, the organisation may determine the best way to reach out to them and capture their needs and requirements and ultimately their values.

2.2.1 Stakeholder engagement in briefing

Stakeholders are defined as those individuals or groups who may affect or be affected by the achievement of an organization's objectives (Freeman, 1984). They are identified by their interests in the organisation, where, the interests of all stakeholders are of intrinsic importance (Donaldson and Preston, 1995). In the construction industry, client and stakeholder values (needs and requirements) are captured through the briefing process. Through engagement and direct involvement with a client organisation, stakeholder needs are identified and prioritised to ensure that the optimum combination of benefit and costs is realized.

Previous briefing literature advocated for recognising the needs and requirements of end-users (in our case, patients, staff and the public) as early as possible in the project process (Pena and Parshall, 2001; Barrett and Stanley, 1999; Blyth and Worthington, 2001). Furthermore, INVOLVE (2005) identified several benefits of stakeholder participation and engagement, suggesting benefits such as, greater social cohesion; improved quality of service, projects or programmes; and, greater capacity building and learning among others. Even so, the challenge of engaging early with stakeholders (end-users) has been raised before (Boyd and Chinyio, 2006; Emmitt, 2007). Holt (2001: 149) argued that "involving these stakeholders throughout the facility 'life' can cause costly interruption to service delivery, as well as reflecting unduly the interests of a powerful or vocal minority" Hence, the challenge is to innovate ways through which to maximise positive benefits attainable from stakeholder involvement or engagement. This would include ways of dealing with conflicting stakeholders demands that may disrupt the planning process leading to an impasse or even affect eventual project success and satisfaction in the finished facility. Renn *et al*. (1997) emphasized the significance of systematic procedures that could possibly be used to reach consensus on values and preferences with stakeholders. They perceived that participatory processes that combine technical expertise, rational as well as moral decision-making, and public values are needed. Furthermore, they suggested processes such as negotiation, mediation and arbitration as likely solutions. Through such processes, the challenges encountered in multi-stakeholder negotiation can be surmounted. Based on this, negotiation may be a probable solution for easing stakeholder engagement issues in construction briefing.

2.3 Trade-off and Negotiation

Delivering modern healthcare facilities, within limited resources, under today's dynamics and demands is an undisputable challenge. The presence of multiple stakeholders and a myriad regulations and standards to be complied with, inevitably implies a possibility of competing goals and criteria. This subsequently results in the need to trade-off between the different criteria in order to achieve an optimal solution within given resource levels/limits. Trading-off is an option considered when there is nothing else to offer (Chinyio and Akintoye, 2008) as would be the case when trying to meet all stakeholders' needs within a limited resource pool. This is particularly feasible when other means such as compensation are not viable in meeting stakeholder demands. Typically, this would be the case when planning and designing with, and for, multiple stakeholders who feel that all their individual value input must be considered and reflected in the design, moreover, compensation would not be feasible in meeting different demands of NHS construction project stakeholders

Because the NHS is now required by law to involve all in decision-making, and, further because stakeholders and the public are aware of their empowerment, they consider it as a given that they are to be consulted before any major project is to be carried out. Therefore, through negotiation collective understanding of what to trade-off can be gained for both sides. The NHS as the initiator can use the process to highlight to the stakeholders constraining challenges while at the same time bargaining for value criteria within its limits leading to a win-win situation. Such a situation may not necessarily imply that all stakeholder demands are met, rather that there is a collective understanding of a problem at hand.

Bellucci and Zeleznikow (2005) perceive negotiation as a process by which two or more parties communicate or confer with the aim of resolving differences between them. They further report that numerous models have been developed to demonstrate how people negotiate. Formal models are mainly derived from game theory, negotiation analysis and economics and are based on objective hard issues while models such as Positional Bargaining and Principled Negotiation derive from behavioural research based on individual norms and behaviours. Traditionally, negotiations between two parties were often expected to conclude with one party winning and the other losing. This is what is known as the 'zero-sum' game based on a win-lose proposition (Schmid, 1998). However, in some situations, the result could even end up in a lose-lose situation when parties take extreme positions (Gatchalian, 1997).

Negotiations are significant in resolving conflicts. They provide the opportunity to reach a win-win or integrative solution thereby improving the positions of both sides beyond the status quo (Sebenius, 1992). The success of any negotiation depends on the ability of negotiators to develop an understanding of the goals and preferences of the other party/parties. "A clear challenge is to find trade-offs that satisfy as many concerns and needs as possible, and thus provide a base for forthcoming project decisions" (Olander and Landin: 560). All this should be based on consideration of the possible consequences, resulting from the decisions made, on all the different stakeholders.

2.3.1 Challenges in negotiation process

Meppem (2000) observed that participant involvement usually involves listing various people's ideas and wants, rather than having facilitated processes to discuss how these were arrived at. He further noted that stakeholder participation has been cited as an ambiguous term with positive overtones that relate to win-win situations. When this is the case, participants are most likely to negotiate for trade-offs based on such a 'wish list'.

The other challenge is that concerns and priorities are not static. They change over time with new classes and configurations appearing in response to changing circumstances (Olander and Landin, 2008). Usually, the negotiation process involves an ongoing exchange of information and often changes in context. Therefore, negotiations reinforce the need for re-assessment and revision of preference criteria because attributes and preferences that at one point were not relevant may later become critical (Kersten and Mallory, 1999). Therefore, having negotiated priorities at an earlier stage, management needs to develop an awareness of this fact and to devise a strategy of how to deal with it in case it materializes.

3.0 RESEARCH METHOD: CASE STUDY INTERVIEW

3.1 Methodology

The study involved a small UK Primary Care Trust (PCT) organisation and was initiated by the authors by contacting the Trust's Estates and Facility Manager. The individual was selected because he was a professional with considerable experience of healthcare projects procured under different methods. Thus the expectation was that he could provide rich data about the early decision making phases and pre-design briefing, of healthcare projects. This assumption was proven in the interviews, which lasted for approximately one hour, and which were held five and half months apart.

The first unstructured interview between the researchers and the facilities manager involved a discussion of the Trust's briefing practices. The key research questions involved were: how can briefing and decision-making be improved under the new model of service delivery involving multiple stakeholders in healthcare construction project planning? The second interview was semi-structured, exploring a variety of topics in more detail based on preliminary analysis of the first interview and the findings from the literature review. Among the questions was how the PCT handles negotiating trade-offs in decision-making. The first interview was manually recorded while the second was recorded by electronic voice recorder, which was then transcribed. The results of both interviews were analysed through content analysis methodology. In the analysis, words and phrases used by the interviewee were examined within a wide range of texts based on reviewed literature. The findings reported here are excerpted from both interviews.

3.2 Background : evolution of NHS project definition process

In the past, when service plans were approved, a Healthcare Trust would receive a lump-sum amount and proceed to design and build in compliance with Health Technical Memoranda (HTM) and Health Building Notes (HBN). Over time, with changes in Government policy, capital charges (interest and depreciation) were introduced meaning that Trusts started getting charged for the initial capital extended to them by the central government. Furthermore, before getting funds the planning had to be subjected to clear business cases and business plans based on Capital Investment Manual (CIM) guidelines. Hospitals were mainly acute service-based, provided at very large centrally located centres. More recently, healthcare has been devolved back to community care with services being provided within a local community area (nearer home).

3.3 Findings: Challenges with present model of NHS infrastructure delivery

The interviewee was of the view that this local community care model has changed the way that money is invested in the NHS. Planning, design and construction procurement, were originally procured through competitive lump-sum tendering arrangements, but are now through consortia such as Private Finance Initiative(PFI) or Local Improvement Finance Trust Companies (LIFTcos). These consortia then take on all major tasks of designing, constructing, maintaining and initial ownership functions from the PCTs.

In the interviewee's opinion the major challenges arising from the recent Community care/LIFT arrangements stem from the fact that unlike former Acute Trusts/Lump-sum finance arrangements, the new model dictates that buildings are designed by committees. 'Design by Committee' is characterised by seeking input from a local design review board who evaluate development proposals on aesthetic and/or urbanistic grounds (Zotti, 1987). Design review board membership includes design professionals, concerned citizens, and planning and general staff representatives (Zotti, 1987; Schartz, 2006). The interviewee's experience is that collaborative design by committee implies taking account of anybody's views. Consequently, Design by Committee often leads to poor building designs. Also, through the collaborative approach, the Trust has been forced to take views of people who may not understand what they are commenting on and consequently not realise the impact it has on the rest of the building. An example of this is when members unknowingly comment or even oppose criteria for specialist (technical) clinical spaces whose functionality they are not fully conversant with. The other challenge mentioned is that, in his opinion:

> *"When you throw something open, for example public consultation, you are bound to get more attendance from people with something to moan (complain) about and less from those who think service is good or are capable of constructive involvement".*

3.4 Negotiating trade-offs

The Trust proactively deals with negotiating trade-offs by aiming to define the brief adequately enough, while at the same time keeping precise criteria open through output rather than via prescriptive specification. The Trust's process is also such that before engagement, ground rules are laid down for the participants, highlighting the known key issues in a given project. For example, site and financial constraints as well as an outline of regulatory standards to be complied with. Hence, when setting and agreeing project criteria they act as basic guidelines during the meetings. He mentioned that through this procedure, all parties are prepared to follow or be guided by these rules of engagement. Together with such project specific issues, decisions are then driven by a balance of issues arising from the national and NHS regulations as well as from a local context. The interviewee also emphasized the importance of keeping committee members as well as the public informed and in constant dialogue in order to avert any conflict that may arise. The opinion is that:

> *"When stakeholders are informed of the relevant issues they are bound to understand what may or may not be achievable, consequently there is less possibility of conflicting requirements".*

In the interviewee's experience, during the early stages, executives and project management may be interested in shaping design decisions from a business perspective while end users may be interested in influencing design decisions that affect the functionality of the final product as well as in modifying requirements. The challenge here is in reconciling the different needs and getting participants to listen and to be considerate of others' needs. The interviewee noted that should a conflicting situation arise, he takes note of the most vocal participants with whom he initiates one-to-one dialogue. During the dialogue, he explains the project constraints and other issues of concern and tries to convince them into trading-off in exchange for something else that may be of importance. For example, the need for a bigger doctor's space (more expensive criteria) could be traded-off with a promise to have finishes of their choice (cheaper criteria).

4.0 DISCUSSION

As witnessed from the interview excerpts, the role of effective communication in successful negotiation cannot be over-emphasized. Communicating the various aspects of a project, be they good or bad will be important in realistically defining the perceived benefits and negative impacts, if any. This consequently eases the negotiation process in that the terms by which trade-offs are possible together with the resource pool to meet needs and requirements would have been established. Moreover, the earlier stakeholders are informed the better, that way expectations will not be raised beyond what can realistically be achieved.

Furthermore, the need to provide a forum in which stakeholders together with their representatives, build trust and feel at ease to discuss amicably what they value most is important. As Barton and Pretorius (2004:20) precisely put it, "what may be needed for public sector projects, is direct interfacing of the various stakeholders in a forum where they can work together and, vitally importantly, learn from each other". That way an understanding of what matters, in addition to why it matters, can be shared. The result of this being that stakeholders will not engage in negotiations with an adversarial attitude that their needs or 'wish lists' must be met. Rather they will seek to come to an understanding of how best to make it work for the benefit of all, and therefore willingly give up/trade-off a criteria for the sake of the group that needs it most. Eventually, collectively informed decisions will be made; moreover, in such a way that will lead to a win-win situation in which the stakeholders feel empowered to have influenced a decision and understood each others value preferences.

The NHS Trust featured here has demonstrated a simple, if quite authoritarian way (cf. laying ground rules before formal engagement) of dealing with conflicting pre-design scenarios. However, the Trust's method does not seem robust enough to counter complicated situations should they arise. Moreover, being a small community Trust, they are less likely to get into a challengingly controversial situation as would be expected of a more complex Acute Trust with many more stakeholder groups and operational function requirements.

5.0 Conclusion

Dealing with multiple stakeholders can be challenging to any process. This paper has attempted to depict how much more challenging it can be to the pre-design construction processes in which major decisions are taken. Communication has been shown as key to building relationships and a basis for successful negotiation. For a more structured and robust approach, negotiation could be adopted along such methodology as Principled Negotiation based on recognizing higher level interests and common ground (Fisher and Ury, 1987). Principled Negotiation also looks to create a wide range of mutually beneficial options in order to avoid becoming entrenched in fixed positions that impede progress to a good solution. Bustard (2002) noted that it is highly relevant when used right from the outset for determining initial requirements and for setting the context for the project. He further highlights its appeal as a basic yet thorough approach reflected through its four key ideas. Together with its underlying moral position of encouraging a search for fair solutions while treating people (stakeholders) considerately in the process, it may therefore be a solution to negotiated bargaining of requirements or project criteria. Principled Negotiation makes a win-win situation possible especially when parties use a common set of principles and framework for negotiation. This may particularly be relevant to the early stages of the now characteristically democratic multi-stakeholder NHS construction projects in which every one's view must be taken into consideration. The rich data obtained from the interviews has helped to identify some pertinent issues to be carried forward into the ongoing research.

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BIM Application for Integrated Design and Engineering in Small-Scale Housing Development: A Pilot Project in The Netherlands

Rizal Sebastian [1], Willem Haak [2], Eric Vos [3]

ABSTRACT

On average, by the time when 1% of the project costs are spent in the design phase, roughly 70% of the life-cycle cost of the building has been committed. Therefore, it is essential to integrate the multidisciplinary knowledge over the life-cycle of the building into design. Building Information Modelling (BIM) is one of the most important supporting factors for a successful integrated design. BIM makes it possible to integrate information from the project participants of different disciplines which traditionally work in different phases of the building process. The application of BIM has been seen in a number of large-scale construction projects, such as in commercial and industrial real estate and infrastructure sectors. The projects in the housing sector, however, are predominantly rather small-scaled and carried out by small and medium enterprises (SMEs). These SMEs have a need to innovate and are looking for practical and affordable BIM solutions.

This paper reports the knowledge dissemination activities through a pilot project of small-scale housing development in the province of Zeeland, The Netherlands. The knowledge of integrated design and engineering and BIM derived from European and national research projects is disseminated to the SMEs through a series of experimental working sessions involving SMEs, i.e. project developer, builder, architect, structural engineer, HVAC contractor, electrical contractor, prefab concrete manufacturer, prefab roof manufacturer, and component supplier. The conceptual knowledge is translated into a working protocol for direct impacts in terms of cost reduction and quality improvement. BIM knowledge is applied without having to radically upgrade the SMEs' ICT systems and organizational capacities.

KEYWORDS

BIM, integrated design and engineering, collaboration, SME, knowledge dissemination

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1. INTRODUCTION

Zeeland is a province located in the south-west of The Netherlands which consists of a number of islands. In this region, most housing developments are rather small-scaled and carried out by small and medium enterprises (SMEs). These developments are based on a traditionally fragmented process (as illustrated in Figure 1) in which the project participants of different disciplines work subsequently in different phases. Based on the practical observation, 10%-25% loss of efficiency occurs in each project due to unplanned redesigns and ad hoc modifications during the construction. This inefficiency results in delays in the delivery, suboptimal end-product quality, a higher price for the client, and lower revenue for the building participants [HZ 2007].

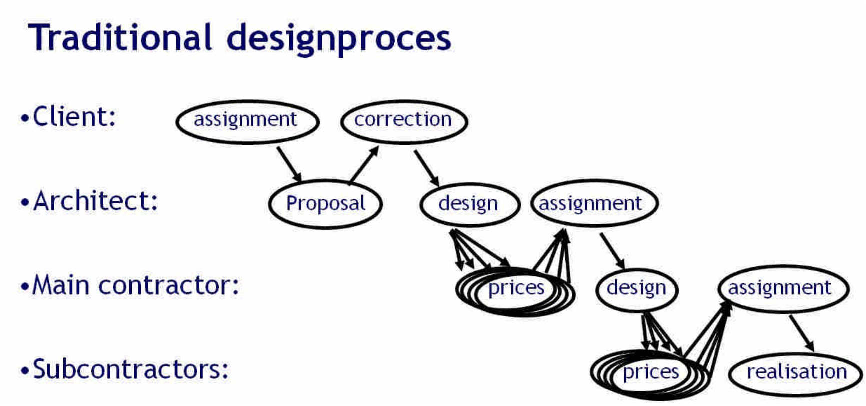

Figure 1: *An illustration of traditional building process for housing development*

Integrated design has been an important topic in the building industry in The Netherlands for the last two decades [Goossens 2006]. Recently, a number of SMEs from the building industry have decided to learn and adopt integrated design approach in order to solve the fragmentation problem in the traditional building process. However, practical methods and affordable tools to perform integrated design in small-scaled housing developments are still difficult to find.

From the pragmatic viewpoint and within the context of the projects by the SMEs, integrated design is defined as a working method to integrate information from all project participants of different disciplines since the design and engineering phase. By obtaining and integrating information from different disciplines, it is expected that the decisions during the design phase are made with the knowledge of the implications for the constructability, use and maintenance of the building in its life-cycle. For instance, as contractors and component manufacturers are involved during the design phase to contribute their knowledge of the construction and production techniques, the architect's design should be fully feasible to construct, so that redesigns and modifications during the construction stage can be prevented.

The growing interest on integrated design cannot be separated from the developments in ICT, among others Building Information Modelling (BIM). All of these developments are targeting at the sharing of coherent design, construction and building information, generated and maintained throughout the life cycle of a building, for time and place independent collaborative working that need to be managed properly [Sebastian *et al.* 2009]. BIM is not the same as the earlier known Computer Aided Design (CAD). BIM goes further than a digital (2D or 3D) drawing or a centralised database [Bratton 2009]. BIM is a computable representation of all physical and functional characteristics of a building. BIM in its ultimate form provides the potential for a virtual information model to be handed from design team (architects, surveyors, consulting engineers, and others) to contractor and subcontractors and then to the client [ConsensusDOCS 2008]. BIM makes it possible to integrate information from the project participants of different disciplines which traditionally work in different phases within the building life-cycle.

This paper reports the activities and results of a knowledge dissemination project initiated by HZ University of Applied Sciences and TNO –the Dutch organization for applied scientific research. The knowledge dissemination activities were conducted within the grant research projects RAAK-Wooneconomie 2 and TNO-MKB Technologiecluster, in collaboration with 10 SMEs from Zeeland. The main objectives of the project are:

- Clarifying the practical implications of integrated design for SMEs through improved communication and collaboration processes
- Adopting BIM applications and modelling tools to support integrated design. BIM knowledge from European and national research projects is transferred to the SMEs and translate this knowledge into practical collaboration methods for small-scale housing developments. The knowledge dissemination

The project is undertaken according to a pragmatic approach of action learning. Knowledge dissemination takes place through a series of experimental working sessions involving the project developer, builder, architect, structural engineer, HVAC contractor, electrical contractor, prefab concrete manufacturer, prefab roof manufacturer, and component supplier.

The next section describes the conceptual knowledge refer to literature and several European research projects and reviews how this has been translated into relevant knowledge by the SMEs in Zeeland. In the following, the pilot project and the experimental working sessions of integrated design are presented, including the specific problems and achievements of each working session. Finally, conclusions are drawn after comparing the achievements to the project objectives and several recommendations are given on further research and practice.

2. CONCEPTUAL KNOWLEDGE REFER TO LITERATURE AND RECENT RESEARCH PROJECTS

Integrated design is a part of an integrated building process. In FP6 European research project ‘Open Building Manufacturing (ManuBuild)’, a new paradigm for integrated building process is introduced by combining building production based on manufacturing in factories and on construction sites, and open systems for designing products and components. ManuBuild presents a mass customisation approach which allows building designs to be customized to the clients’ and users’ needs while utilizing industrialized building systems. Industrialized building systems are sets of parts and rules to generate different products based on standard components and through similar processes [Kazi *et al.* 2007].

In ManuBuild it is argued that –based on the fact that buildings are site-related and technology is factory-related– industrialized building systems can be put in three categories, namely: site assembled kit-of-parts, factory-made 3D modules, and hybrid [Richard 2007]. In the site-assembled kit-of-parts category, all subsystems including the structure are made at specialized plants and then transported to the site as separate parts. The important jointing operations take place at the building sites. In the factory-made 3D modules category, all spaces and components of the building are entirely made, assembled and finished at the plants.

At the building sites, the 3D modules only require simple connections to the foundations, between themselves and to the main service conduits. The hybrid category is aiming at the best of worlds, site and factory. Manufacturing of the complex parts takes place at the factory. The size of the modules is kept relative small for easy transportation to the building sites.

On the practical relevance of this knowledge for small-scale housing developments by SMEs, this paper discusses the strategy for integrated design in each category. In the site-assembled kit-of-parts category, integrated design is initially focused on defining the room for creativity for the architect, or in other words: the possibilities for customization based on the information of standard components and systems from the manufacturers and subcontractors. In a later phase, detailed design for prefabrication is elaborated together with the manufacturer and contractor. The contractor's main task is coordinating the assembly of prefabricated components by different subcontractors at the building site. Herewith, BIM can be used to guide how the prefabricated components should be put together to form a building. In the factory-made 3D modules category, all disciplines should work together using one model (BIM). The finished model represents the completed building. BIM is used to produce and assemble the building at the factory; and in some cases, also as an input to operate the manufacturing machines. In the hybrid category, integrated design is crucial for planning and logistics management next to other purposes in the first two categories.

Going further on BIM application to support integrated design, much can be learned from FP6 European research project 'Open Information Environment for Knowledge-Based Collaborative Processes throughout the Lifecycle of a Building (InPro)'. On average, by the time when 1% of the project costs are spent, roughly 70% of the life-cycle cost of the building has been committed. Therefore, InPro develops a conceptual framework for collaborative decision making by the clients and project participants based on open information environment during the early design phase. The use of BIM offers the opportunity to carry out a performance-based design through which information on the future building performance is considered in design decision making [InPro 2009a]. As illustrated in Figure 2, in the InPro project BIM consists of three main aspects, namely: 3D visualisation, specifications, and cost estimates. Each decision is taken after verifying the design based on the requirements and performance analysis. In the decision making process, ideas are translated into concepts, then elaborated in proposals, then approved as results.

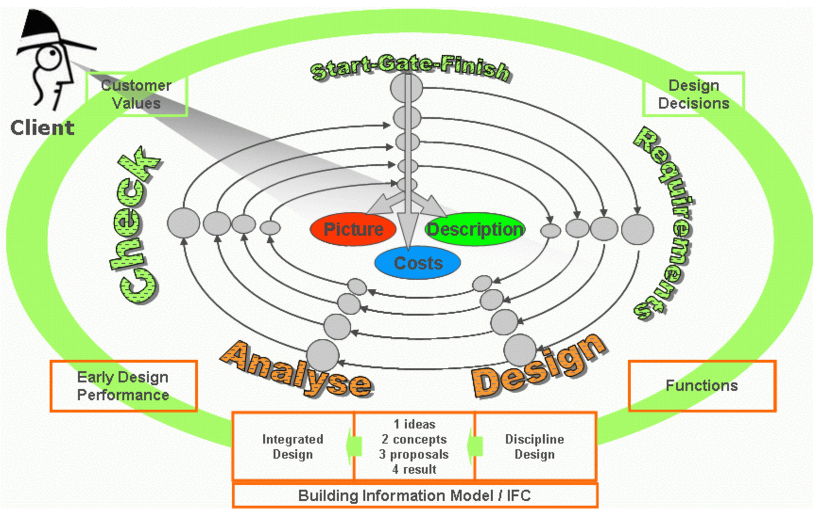

Figure 2: *Integrated design with BIM application (source: unpublished presentation by F. Verhofstad et al. in the InPro EU FP6 research project)*

On the practical relevance of this knowledge for small-scale housing developments by SMEs, this paper discusses the intermediate steps for the transition from the traditional building process towards integrated design with BIM application. In the current situation, the project participants use individual information storage and different drawing software applications. For performing integrated design using a centralized model, an international open standard, such as Industry Foundation Classes (IFC), are needed. IFC is a software-independent format for exchange and integration of building information. Although the IFC standard is generally agreed to be of high quality and widely implemented in software, the certification process allows poor quality implementations and renders the certified software useless for practical usage with IFC [Kiviniemi *et al.* 2008]. While progressing with the open standard in accordance to the further technological development at international level, SMEs in Zeeland can already begin by adopting a partly-open standard approach. The traditional process of bilateral information exchanges can be replaced by centrally storing important information using the agreed format. This information should be interactively linked to a central model of the building which is regularly updated and made accessible to the project participants. The client (or project developer) can act as the manager of the model and facilitator of the communication process. Such partly-open standard approach can be used before a fully integrated and automated process with IFC open standard is applied.

Since recently, the SMEs can make use of a free-of-charge open source BIM server for organizing central information storage, building model and applications. The open source BIM server has been jointly developed by TNO and Eindhoven University of Technology. It is an application which enables an IT server to operate as a BIM server. Its core is based on the IFC open standard, and therefore, it can handle IFC files. The BIM server uses the reference for implementing Building Information Exchange Protocol, which is a new standard developed by the Open Source BIM foundation. It is published with the GNU GPLv3 licence, which is free to use (www.bimserver.org).

The existing conceptual knowledge referring to literature and recent research projects can provide an adequate basis for the SMEs to perform integrated design. However, there are certain knowledge gaps which can only be filled-in through practical experience. The technology-readiness level for prefabrication may have been sufficient, but there is lack of experience of working in a co-makers consortium to achieve the optimal result of integrated design and open manufacturing as suggested in ManuBuild research project. If the framework for collaborative decision making as proposed in InPro research project is to be implemented, the project participants should be able to communicate design alternatives for verification using a multidisciplinary viewpoint. Before either an open standard approach or partly-open standard approach can be performed, each project participant should comprehend the broader functionalities of their software and share this knowledge with the others. These knowledge gaps were addressed in the pilot project and experimental working sessions, which are described in the next section.

3. PILOT PROJECT AND EXPERIMENTAL WORKING SESSIONS OF INTEGRATED DESIGN WITH BIM APPLICATION

The pilot project in Zeeland, The Netherlands comprises 4 houses as a part of a small-scale complex of residential estate consisting 9 stand-alone family houses in the village of Koudekerke (see Figure 3). This project is similar to a recently finished project. The previous project was carried out through a traditional design and construction processes (e.g. relying on 2D drawings). Using the current project as a pilot for integrated design with BIM, the participants expect to discover the benefits of integrated design through a direct comparison with the previous project.

This pilot project is an example of a typical housing development in Zeeland with the following development process. A project developer initiates the project by purchasing a building site and preparing it for the realisation of a small-scale housing estate. The project developer is in fact the client that contracted the other building participants, namely: architect, structural engineer, installation companies, etc. The client develops this project based on its marketing strategy, and manages the design, construction and delivery processes. Once the project is finished, the houses will be sold to the consumers/end-users.

Figure 3: *A 3D model and a picture of the pilot project of small-scale housing development in Zeeland, The Netherlands, with integrated design and BIM application*

The learning aim through the pilot project is to introduce an integrated working method to reduce the loss of efficiency in collaborative processes with the building participants, and to increase consumer's satisfaction by communicating the design ideas through 3D visualisation which can be better understood by the consumer/end-user. By this, redesigns and changes during the construction due to errors and additional consumer's requirements can be significantly reduced. The pilot project is expected to yield direct impacts in terms of cost reduction and quality improvement, without having to radically upgrade their ICT systems and organizational capacities of the building participants.

The methodology for knowledge dissemination and the learning process can be described as follows. Within the knowledge dissemination projects RAAK-Wooneconomie 2 and TNO-MKB Technologiecluster, the abovementioned aim is addressed through a series of experimental working sessions with 10 SMEs. Nine of the ten SMEs are directly involved in the roles of client and building participants in the pilot project. These companies are selected based on their interest and motivation to innovate their products and processes. These companies represent the entire building supply-chain: client, architect, main-contractor, structural engineer, HVAC contractor, plumbing contractor, electrical contractor, prefabricated concrete manufacturer, prefabricated roof manufacturer, and component supplier (kitchen and bathroom furniture).

Each experimental working session is hosted by one of the SME participants. This SME initiator nominates its most important problem (comparable to a research / learning question) in the design process. Other building participants that work directly with this company in practice are invited to join in. The programme of activities is as follows. Each experiment is conducted on one day. The SME initiator introduces the problem and explained their role in the design process. The problem is then discussed as a case in direct relation to the pilot project. All participants work together to solve the problem / the case using the method of integrated design and BIM. When needed, an external advisor or a specialist is asked to guide the experiment. The results of the experiment are evaluated at the end of the day and the applicable lessons for the SME initiator and other participants are formulated for further implementation.

In each experiment, a problem observed at the pilot project is highlighted as a case. For instance, during the experiment at the HVAC contractor, the 3D model derived from BIM of the pilot project was able to detect clash problems, among which between a ventilation duct and a sewer water pipe in the semi-prefab floor (Figure 4). During the experiment, the participants were engaged in communicating the problem with the architect, installation contractors, floor manufacturer, and bathroom furniture supplier. Through collaborative design and engineering they managed to find an integrated solution in a new layout of the bathroom and installations.

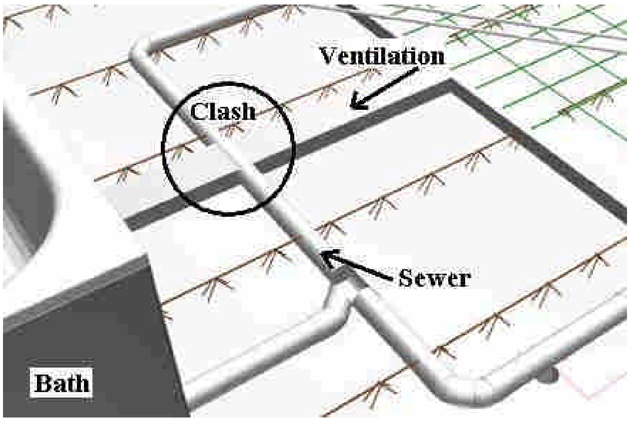

Figure 4: *A 3D image of the bathroom of the pilot project detecting a clash problem between a ventilation duct and a sewer water pipe in the semi-prefab floor*

Regarding the communication, the experimental working sessions focuses on the exchange and integration of information between different disciplines with their software applications, e.g. Nemetschek AllPlan, AutoCAD, Arkey, StabiCAD, StruCAD, SaniNet, Simar. The 3D model/BIM of the pilot project is developed using AllPlan. During the experiments, different possibilities have been researched, ranging from open standard with IFC, exchange and integration of 3D models through AutoCAD and 3D-Studio format, to a basic information exchange in 2D format. It appears that not all software applications used by the building participants can handle open standards. Despite the fact that an open standard, such as IFC, is not applied in the experiment, the exchange of information is successful to a certain extent due to the agreements on the format of drawings and specifications made between the building participants.

The subjects of the experimental working sessions, the relations between them, and the results are presented in Table 1.

Table 1. Summary of the problems and main results of the experimental working sessions

No	*SME initiator*	*Problem / learning question*	*Result*
1	Client (project developer and main contractor)	How to set up BIM and associate the 3D model to cost calculation application	A prototype of BIM linked with the currently used cost calculation application
2	Architect	How to get an immediate insight in the cost implications of the design alternatives	A method to get an immediate and more accurate cost estimate during modification of the building model
3	Prefab concrete manufacturer	How to accelerate the design process of prefab concrete floors through effective communication	A protocol for integrated decision-making by all disciplines using the support of 3D model
4	Prefab roof manufacturer	How to agree on the accountability of the structural design between the engineer and manufacturer when a prefab solution is used	A 3D model integrating the prefab solution to the main building model, and indicating the limit of the accountability of each party
5	Electrical contractor	How to agree on the format of drawings for information exchange between main contractor and electrical subcontractor	An agreement on an efficient layer structure to accommodate the integration of 2D electrical elements within the 3D building model
6	Plumbing contractor	How to import and export 3D information between StabiCAD and AllPlan	Several techniques to utilize 3D import and export functions in StabiCAD and AllPlan
7	HVAC contractor	How to detect the possible clashes of HVAC installations using 3D visualizations	The discovery of 5 clashes in the pilot project which were then solved during the experiment
8	Structural engineer	How to use BIM resulted from the design stage to check and approve the quality of the structural elements during the construction stage	A technique to obtain visual information from the building site to compare as-built elements with the structural design in 3D, e.g. the position of reinforcement in concrete
9	Component supplier (kitchen and bathroom furniture)	How to improve the communication and decision-making processes in case of modifications of building elements and installations based on the customer's requirements	A proposal containing new functional requirements for ICT infrastructure within the international holding of building component supplier to solve the current limitations

In the analysis of the achievement of the experimental working sessions with all participants, the added value of integrated design and engineering becomes evident as many interface problems can be solved before the construction begins. This saves much time and cost for redesign and repairs. Another proven added value is the earlier involvement of the contractors, subcontractors and suppliers during the design process which makes it possible to get a better insight in the consequences of the design decisions for the construction and delivery. Refer to the main objectives of the knowledge dissemination project as described in the introduction section of this paper, the analysis focuses on which technological innovations are the most relevant for the SMEs and which process and organisational changes are needed to apply integrated design and engineering.

For the SMEs, the most relevant technological innovation is the 3D visualisation which enhances multidisciplinary communication. Most of the SMEs are still in the stage of transition from 2D drawing to 3D CAD. The transition from 3D CAD to a full-performing BIM still needs to take place. Although the SMEs did some experiments with clash detection, planning, and costing tools, as well as open source data sharing, they are not yet ready to use these tools at the full extend due to the limitations of the existing ICT infrastructure. In the future, the SMEs in Zeeland aim at integrated design using BIM which comprises 3D visualisations, material specifications and cost estimates.

On the process and organisational side, some concrete steps have been taken, such as: the establishment of a list of agreements for a more effective communication and data exchange between different disciplines, e.g. data format, layer structure, drawing / document requirements, and schedule. Since the management of the SMEs are involved in this knowledge dissemination project, the decision to adopt the approach of integrated design and engineering can be taken shortly. The intention to achieve an effective multidisciplinary collaboration is positively supported by the fact that most of the SMEs involved have already possessed some experience of working together in previous projects. These SMEs are also willing to research the advantages of the integrated procurement methods (e.g. design-and-build) and the possibility to form a multidisciplinary project consortium to undertake such tender in the future.

4. CONCLUSIONS AND RECOMMENDATIONS

Having analysed the main results, it can be concluded that the knowledge dissemination project with the SMEs in Zeeland is successful due to the following factors. First, the combination between the transfer of conceptual knowledge derived from literature and other research projects with the pragmatic approach of action learning has been proven very effective. Second, the use of a pilot project as an actual case study is very helpful. Since almost all participants are professionally involved in the pilot project, they recognize the real problems in the traditional building process and they can experience the improvements through integrated design with BIM. Third, modelling the building project in BIM represents the progress of knowledge development. The model has been gradually enriched by participants from various disciplines throughout the series of experimental working sessions, starting with a 3D building representation and adding detailed objects and information. Last but not least, each experimental working session is organized at the premise and facility of the SME involved. This offers the SME a direct opportunity to share and implement the new experience in its company.

Next to these achievements, the following limitations have not been solved in the projects. The exchange and integration of information using BIM is still limited to the form of the objects (3D visualisation). The specifications are added manually, while the 'intelligence' of the model (e.g. automated jointing solutions) is left behind as a model is transferred from one software application to another through an AutoCAD format instead of an open standard. Furthermore, while the SMEs are seriously motivated to perform integrated design, they are still to engage with transformation of internal organizational strategy and external business strategy to establish sustainable collaboration within projects and in the supply chain.

Nevertheless, the projects can yield a broader impact in the building sector in The Netherlands. At present, integrated design using BIM has been implemented for large-scale projects, such as commercial and industrial real estate and infrastructure projects [CPI 2008]. RAAK-Wooneconomie 2 and TNO-MKB Technologiecluster projects have shown that SMEs engaged in small-scale projects can adopt relatively simple working methods with a basic BIM for direct impacts without having to radically upgrade their ICT systems and organizational capacities at a high stake. The direct impacts have been experienced in terms of a better quality of the end product (i.e. interface design errors were visible and solved using BIM), reduced costs (i.e. on-site modifications were prevented), reduced time (i.e. less steps needed for decision making), and a higher employee motivation and human resource effectiveness due to exposure to new possibilities through new knowledge.

For the SMEs, in order to progress with integrated design and engineering using BIM in the future, the following recommendations are relevant. The client and project participants should establish a sustainable strategy to manage the process by optimizing the benefit of integrated design. This should be followed by an integrated procurement strategy which facilitates a transparent and productive collaboration. For instance, if the project participants are asked to contribute to improve the design and eliminate the design errors by using BIM, they should be entitled to a fair distribution of the additional profit from a successful project delivery with a higher quality and shorter time. Such agreement should be formalized in the division of tasks and responsibilities in the project organization. Moreover, an open protocol comprising a collaborative working method and a template to develop BIM and object libraries in housing projects is needed. This will save time and effort to establish management and ICT protocols at the initiation of each new project. Finally, coordinated actions with the local authorities and professional associations are important, so that integrated design can be supported by an efficient building permit procedure and its method and organization can be included in professional standards, such as by the American Institute of Architects [AIA 2007].

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SECTION 3

MANAGEMENT, PRESERVATION AND RECONSTRUCTION OF HISTORICAL BUILDINGS

A study on Establishing a General Theory and an Operational Model with the Settlement Preservation in Taiwan's Historical Urban Area

Hung-Chi Song [1]
Shih-Ming Chen [2]

ABSTRACT

In order to prevent the decay of the architecture cultural assets from the old building facing rebuilt. This study attempts to establish a general theory and an operational model with the settlement preservation in Taiwan's historical urban area, to probe into the architectural double-sided issue about the cultural preservation and the building volume. The main topic is that Taiwan's settlement preservation work has to response two conditions: one is owners have the rights for their building volume because of the historical building being privately-owned, the other is owners also needs a fast preservative method for rebuilding their old house because of the Cultural Heritage Preservation Law being long-winded process. From a practical point of view, Taiwan's settlement preservation work can use the ideal of "current-preservation" to set up an operational mechanism on conditions of existing architectural laws and "volume control", and also answer for the double-sided issue about the cultural preservation and the building volume. Then we can proper to prevent the decay of the architecture cultural assets from the old building facing rebuilt.

The conclusion is that Taiwan's settlement preservation work can use the ideal of "current-preservation" to set up an operational mechanism on conditions of existing architectural laws and "volume control", and also answer for the double-sided issue about the cultural preservation and the building volume. Then we can proper to prevent the decay of the architecture cultural assets from the old building facing rebuilt.

KEYWORDS

settlement preservation, current-preservation, operational model

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1. INTRODUCTION

In "the Implementation Rules for the Cultural Heritage Preservation Law" of 2006, settlement is defined as "Structures and ancillary equipment group which have history of geographical features or characteristics, including Taiwan's indigenous settlement, the Holland-Spain Occupation's street area, Han's street area, residence of foreigners during the end of the Qing Dynasty, settlement during the period when Japanese immigrants, Modern dormitories and residential military community and so on". This article is mainly discuss about the methods of Preservation for the street area during from the Qing Dynasty to the Japanese Occupation, and used Taiwan's historical urban area as title for research and discussion, and to discuss about the pattern of Han's street during the end of Dynasty Qing, and also the historical buildings inside the urban development area since the Japanese Occupation until now, especially to which set to be the historical buildings of high volume area, because the preservation for these type of buildings involve old building which need to reconstruct as soon as possible to fulfill the modern life style and quality. At the same time, the result of urban development that gave housing with high building capacity. This has cause people's discussion on both preservation and development problems.

However, some unusual phenomenon occurs during heritage Preservation work on both historical buildings and historical monuments. This includes 1. Building was destroyed repeatedly before, after or during the assignation process. 2. Government was criticized by all circles because process to set up the preservation law was slow. 3. The cultural property of all people becomes Liabilities for both of owner or administrator. 4. Historical monuments are always out of bound with the development of the area, and becoming the development crisis of the area. 5. After a space is defined as historical space, it becomes the lost space in the city （Liou, S.C. & Chien：2002）. Now, the preservation of historical buildings, even though, these historical buildings are as preservation target, but after investigation, registration until to form a complete law set. Also need central government and local government to agree with related act than the problem can be solve, within this period historical building maybe destroy because owner worry about their building will be defined as public wealth, they will lost their private property disposition, so this cause the historical building to be destroy before legal preservation. Due to the above incident, we have to think enthusiastically: settlement preservation in historical urban area may be preserved under existing buildings act, and how to respond to the owners about the needs of building capacity and also the suitable way to reconstruct the preservation building. This is to save the historical buildings in an urban city from being destroyed.

This research is to address; through "investigation method" find out the value of historical building environment and to explore the basic of "minimum preservation spaces", after the control of current construction act "volume control" and "simulation rebuild mode" for reconstructing the preservation design, estimate all rebuild type of possibility of "part preservation, part reconstruction", as the beginning of the preservation work and participation by local residents.

1.1 The Review of Taiwan's Preservation Act

The cultural heritage preservation Law of Taiwan begin during the Japanese occupation period of 1896 "The Protect Rules For Temple Palace of The Island" and the announce of "Taiwan's Statute for preservation of Natural Monument and historical landmarks" at 1922.

Following after the war at 1929, "Statute for Preservation of historical sites and Antiquities Ordinance", "Law for the Preservation of Antiquities" at 1930, "Tentative Outline For The Scope And Types of Antiquities" at 1935, "The Cultural Heritage Preservation Law" at 1982, "Implementation Rules for the Cultural Heritage Preservation Law" at 1984, "Environmental Impact Appraisal Law" at 1992 and related" Environmental Impact Appraisal Law" are set for historical monument preservation Principe are announce continuously, later on after the incident of 921 earthquake, The Cultural Heritage Preservation Law have complete their correction of the law at 2006 and is used until now. And set up" Regulations of Urban Building Capacity Transfer" (TDR)

Table 1: The related idea and development of Taiwan Cultural Assets Preservation

Style	**Museum Style "Object Preservation"**		**Park Visiting Style "Sightseeing Preservation"**		**Daily Life Style "rebirth Preservation"**
Coverage	Point		Line	Area	Area
Subject	Monument	Single Unit Historical Building	Historical Buildings	Cultural Park	Historical Living Environment
Strategic	Appointed	Appointed	Mark out area Appointed	Registration	Registration
Tools	• Law for the Preservation of Antiquities • The Cultural Heritage Preservation Law	• The Cultural Heritage Preservation Law	• Zoning, • Urban design • The Cultural Heritage Preservation Law	• Zoning, • Urban Design, • TDR, • The Cultural Heritage Preservation Law • Community Development	• Zoning, • Urban Design, • TDR • The Cultural Heritage Preservation Law • Community Development
Target	• Fully Preservation	• Fully Reconstruct Preservation	• Fully Preservation, • Conservation and Reused, Partly Preservation	• Fully Preservation, • Conservation and Reused, • Partly Preservation And Partly Reconstruct	• Fully Preservation, • Conservation and Reused, • Partly Preservation And Partly Reconstruct

1.2 Summary:

From the above discussion, shows that the heritage preservation work in Taiwan have slowly improve from freezing preservation of single building to living style of overall cultural environment preservation. Other than respect the historical value and the authenticity of the building, in other hand it also respect the redevelopment of the social environment. Preservation methods was announce by mark down, appraisal from the top-down of the appointed mechanism, change to the bottom-up of the registered mechanism method, and preservation tools like "Zoning", "Urban Design" and "TDR" are commonly used internationally to get the preservation work and to form multiple preservation tools. This have clearly show that the heritage preservation work of Taiwan is gradually walking toward the objective of taking care on overall cultural environments such as cultural of building, community life, economic development , and used flexibility and multi-level, dynamic way to preserve their culture assets.

2.THE RESULT AND DILEMMA OF TAIWAN'S SETTLEMENT PRESERVATION

2.1 Experience Of Taiwan's Settlement Preservation

In Taiwan there are always entanglements on both preservation and development during the progress of private historical building preservation. So the execution of preservation is not easy because the law has no clearly standardized it. However, from the following three case studies of "old street in Lugang Township, Changhua County", "old street in Sanxia Township, Taipei County" and "old street in Dadaocheng, Taipei County," we knew that heritage preservation work is done by using urban planning act of zoning as tools. Through wards the overall review of urban planning method, to mark out the area as either preservation area or private area. Than subscribe another urban design act to restrict the architecture behavior on historical area. Sometime during the progress, continuous resistance of the residence causes a lot of conflict. Later on, TDR methods can solve the problem of building capacity. This has brought heritage preservation work moving for over 20 years. To the residence for willing to coordinated with the historical preservation work policies and regulations.

2.1.1 Three Case Studies Of Taiwan's Settlement Preservation And The Guildline Of Reconstruct

Case study 1: the preservation plan for the old street in Lugang Township, Changhua

Project Period : 1973～1986

Preservation Plan : "The revised zoning of Lugang urban planning"

Rules of Restriction : there are 4 types of preservation and reconstruction methods; "completely preservation" (façade of the building, interior of the building and related garden), "façade preservation" (façade of the building and related garden), "partly preservation" (whole building of part 1 and 2, further are above the view of the part of the building, it cannot exceed the viewing sight), "normal preservation" (renovate, reconstruction, increase according to the original style, the building height is not allow to exceed 2 floor or 7 meters height).

Case study 2：the preservation plan for the old street in Sanxia Township, Taipei County

Project Period: 1989～2003

Preservation Plan : "The revised zoning of Sanxia urban planning"

Rules of Restriction : style preservation, original outlook, style restriction, and tie with 50%~240% reward of the capacities .

Case study 3：the preservation plan for the old street in Dadaocheng ,Taipei City

Project Period : 1988～2000

Preservation Plan : "The revised master plan & detail plan of Dadaocheng area",

Rules of Restriction : separate into three types, part 1 and atrium preservation, façade preservation, veranda preservation

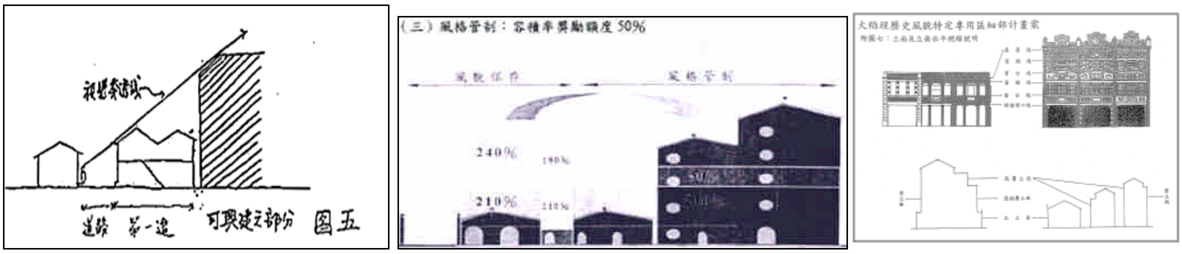

Figure 1：Diagram about the control of building preservation and rebuilt of Lugang & Sanxia & Dadaocheng.

2.1.2 Taiwan's Settlements Preservation Methods

From the review of the above case studies, preservation idea and method can be sum up into 7 methods as below,

1. Maintain the width of the street: this is to protect the historical context of the city and the pattern of the street space.
2. Preserve the façade and the arcade: preserve building outlook to benefit the old building behind to be reconstructed.
3. Control the height of reconstruction: allow reconstruction at specific area; strongly restrain the scenery of the preservation area.
4. Control the style of reconstruction: used "style preservation", restriction the style of the reconstruction behind the façade to control overall historical scenery.
5. Control the view of streetscape: used "historical landscape preservation line", restrain the height of the building behind the façade building maintain the streetscape scenery
6. Capacities Rewards
7. TDR

Table 2: Taiwan's settlements preservation methods

	Lugang's old street	Sanxia's old street	Dadaocheng's old street
Maintain the width of the street	V	V	V
Preserve the façade and the arcade	V	V	V
Control the height of reconstruction	V		V
Control the style of reconstruction	V	V	V
Control the view of streetscape	V		
Capacities Rewards		V	
TDR			V

2.2 Four Dilemmas Facing By Historical Preservation in Taiwan's Settlement

1. The main problem of settlement preservation comes from both topics of preservation and development
2. It is very easy to encounter obstacles and rejections from local residents during the process of Heritage Preservation Work thus causing rapid damages to the cultural assets.
3. The revised "Implementation Rules for the Cultural Heritage Preservation Law" on Heritage Preservation inspective Work is by "Registration", in other words it means "Preservation Will of people", so it still remains on the level of moral persuasion and lack of effective preservation strategy and execution tools.
4. Enforcing Preservation Work is not easy and time-consuming. Before Preservation Law is established, many Historic Buildings had already been pulled down thus losing their value of preservation.

2.3 Current Issues Of Taiwan's Settlement Preservation

The main topic is that Taiwan's settlement preservation work has to response two conditions: one is owners have the rights for their building volume because of the historical building being privately-owned, the other is owners also needs a fast preservative method for rebuilding their old house because of the Cultural Heritage Preservation Law being long-winded process. Now, we face two current issues:

1. Think about the two sided problem of "preservation" and "renew" from the discussion of historical building. How to create a dual win situation?
2. Think about the "strategic" and "tools" during historical buildings preservation. How can be benefit to settlement preservation work?

3. THE STRUCTURE OF CURRENT-PRESERVATION ON SETTLEMENT PRESERVATION

The main topic is that Taiwan's settlement preservation work has to response two conditions: one is owners have the rights for their building volume because of the historical building being privately-owned, the other is owners also needs a fast preservative method for rebuilding their old house because of the Cultural Heritage Preservation Law being long-winded process. From a practical point of view, Taiwan's settlement preservation work can use the ideal of "current-preservation" to set up an operational mechanism on conditions of existing architectural laws and "volume control", and also answer for the double-sided issue about the cultural preservation and the building volume. Then we can proper to prevent the decay of the architecture cultural assets from the old building facing rebuilt.

The theory we need for preservation discussion are about "current, local, simple, basically, multiple, variety, dynamically, continuously". "current, local", is because old building which need to reconstruct is getting much, but there are not appropriate guildlines of preservation for different housing; "simple, basic", is because the rules of preservation is too disorderly and cause the owner resist; "multiple, variety", because the different preservation degree and different historical value of the building, there for the level of preservation and method are different. "dynamically, continuously", because the concept of preservation and development maybe change according to the change of environment, only good response mechanism can help preservation and development work more effectively. The significance of the preservation theory is below.

1. To value great importance to contemporary life
2. Heritage Preservation Work："limited" in rebuilding control.
3. Preservation policies： "variety, multiple, soft, zoning"
4. Strategic："current-preservation"

4. THE OPERATIONAL MODEL OF THE SETTLEMENT CURRENT-PRESERVATION

4.1 The 4 Principles Of Operational Model For Current-Preservation Will Be Explained As Below:

1. The idea of "Minimum preservation space" means "limited preservation work", is partly

conservation, partly reconstruction.
2. The basis of legal norms for preservation is the Building Act not by “Implementation Rules for the Cultural Heritage Preservation Law"
3. Preservation tools: "volume control", " historical landscape preservation line"
4. Reasonable indoor configuration: In response to today modern value of life.

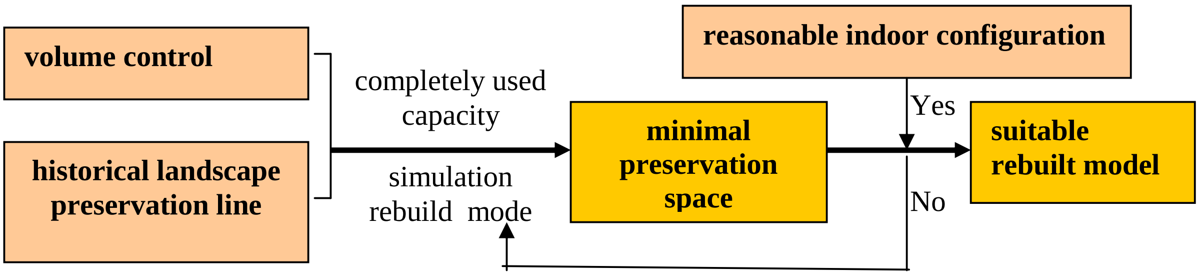

Figure 2 : Diagram of operational model for current-preservation

4.2 The Steps of Simulation Operation for Current-Preservation of Building Reconstruction

Steps 1.：define building preservation restriction

There are 6 level of building preservation restriction: 1. Building façade and street space, 2. Extend until the space of the first hall, 3. Extend again until the first atrium, 4. than extend again until the second hall, 5. Continue to extent until second atrium, 6. Then extend again until the third hall.

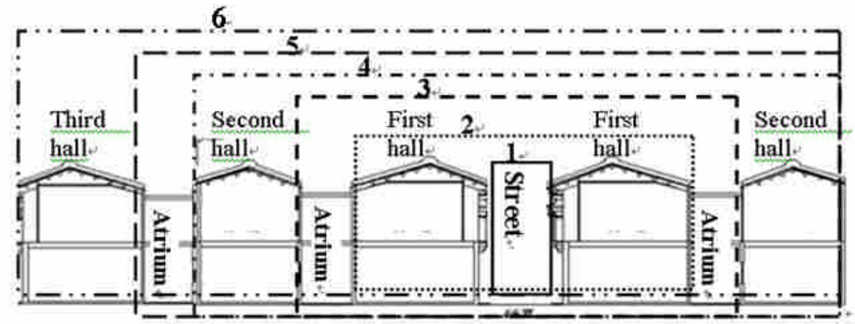

Figure 3: The diagram of 6 levels range of building preservation

Steps 2: diagram is used to explain the simulation of building restriction methods.

“Minimum preservation space” is used as premise for building reconstruction. Than “historical landscape preservation line” is used to control the height of the rebuilding.

The minimal preservation of the space: Faced old street, the first hall and atrium of each building at North-South area.

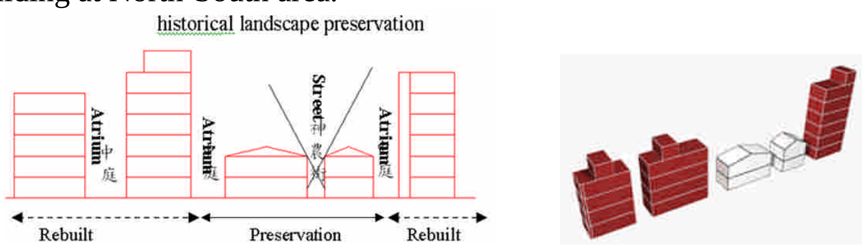

Figure 4: The minimal range of preservation for substances spaces

Steps 3: after satisfying the above two condition, find out more preservation space for old building.

The maximum preservation of the space: Faced the old street, the first hall, the second hall and the second atrium of the building at the north house; phase 1 and atrium of the building at the South house.

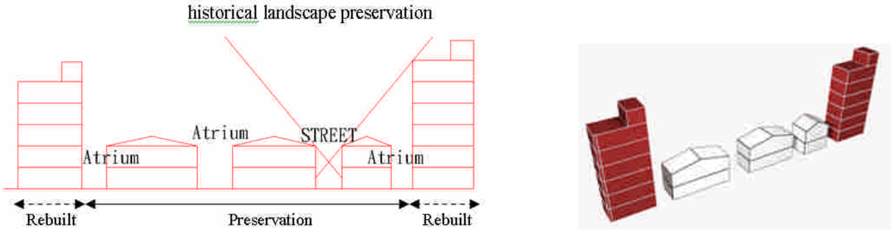

Figure 5: The maximal range of preservation for substances spaces

5. DISSCUSSION

5.1 The Difference between This Current-Preservation And The Previous Preservation: non「Once on the success」、non「building type control」

Because of "Once on the success" lost its flexibility during the communication with residence. It still need a lot of completed package law to proceed the preservation work; "building type control" had cause the resist of the residence due to the non-equal condition of buildings. Even may cause negative evaluation towards the value of cultural property. Therefore, in this article we propose using current building act as accordance. Then set the minimal preservation space of the building. The complete used of building capacity as the premise. The addition of "volume control" and "historical landscape preservation line" to immediately start of private historical building preservation. This research of preservation includes general, current and operational. It mechanism is top-down, to set up the variety of dynamic preservation for "minimum preservation space". It also starts the consciousness of cultural preservation of the residence.

Table 3：The differences between current-preservation and previous preservation

	Previous Preservation	Current-preservation
Target	Setting up the preservation area	To rescue the historical building which are demolish and rebuild
Strategic	Once on the success ,totally preservation	Flexibility of current- preservation
Basic of Law	Cultural property preservation law Zoning Urban design restriction rules Capacity rewards TDR	According to current Building Act
Restriction tools	Building type restriction	Volume control Historical landscape preservation line
Restricted capacity	Unfinished used of legal capacity	The complete used of building capacity as the premise
Efficiency	Takes long time May cause acute destroy of cultural property	Immediately execute Comprehensively rescue historical property

5.2 The Strategic Of "Current-Preservation", Although It Is A Measure For Historical Property Rescued. The Meaning Behind Shows About The Attitude Of Normal Preservation For Historical Buildings.

Previously, experience gain during the execution of settlement preservation. Preservation and development are always the main problem during selection. This may cause acute destroy on cultural property and confront against the preservation consciousness. The long term set of regulation will cause the cultural property to be disappearing slowly. Therefor, when we face private historical buildings, a completed and flexible thinking about cultural, social and economic have to be proposed for preservation work. The "current-preservation" values the building development rights of the owner of the historical buildings, it is also the positive approach to rescue the historical building immediately. The meaning behind show us the attitude of settlement preservation. It also has the ecological meaning of the cultural environment.

5.3 The Simulation Rebuild Mode Of "Volume Control" Can Appraise Effectively The Preservation And Rebirth Of Historical Environment

The method of "volume control" used the idea of "partly preservation, partly reconstruction". The execution of "preserve" and "development" are for dual directional expedition research. It can collectively preserve the cultural spaces in those historical sites and respond to the residents on their rights of using the building volume. It can find out the potential and limitation of the building for reconstruction and to find out the minimum preservation space. This will help on estimation of the space reuse and the impact toward the value of the historical environment.

5.4 "Minimal Preservation Space" Will Help Government to Think About The Appropriate Of the Restriction Limit for Private building.

Through the probe of the value of historical environment and complete used of the capacity after the reconstruction simulation. Further estimate of "minimal preservation space", the proposed of this point is to measure the preservation of the small area with huge historical value, and also probe about the limit of intervene of government into private building. At the same time, to care about the current needs of the living.

5.5 The Variety Proposals Of Simulation Rebuild Mode Will Be Chose A Scheme By People's Mutual Discussion Of Selection, And It Will Help To Start The Preservation Conscious Of The Residence.

The drawing of "simulation rebuild mode" compares to writing, it easily offer the residence to discuss. The variety proposals of simulation rebuild mode will be chose a scheme by people's mutual discussion of selection. And it will help to start the preservation conscious of the residence. The Process has the chance for becoming local rebuilt agreement for the cultural environmental preservation work.

6. CONCLUSIONS

The main purpose is to prevent the decay of the architecture cultural assets from the old building facing rebuilt. This study attempts to establish a general theory and an operational

model with the settlement preservation in Taiwan's historical urban area, to probe into the architectural double-sided issue about the cultural preservation and the building volume. We use the ideal of "current-preservation" to set up a operational mechanisms on conditions of existing architectural laws. "Volume control" and "historical landscape preservation line" are used to control the height of the rebuilding. "Minimal preservation space" is used as premise for building reconstruction. It comes up with variety proposals to offer residence for choice by "simulation rebuild mode". It mechanism is top-down, to set up the variety of dynamic preservation. This model will enlighten people to understand better the benefits for possible coexistence between "Preservation" and "Development". This will resolve in time to prevent at the brink of collapse in those cultural spaces and historical sites. At the same time, because of "Minimal preservation space", then we will allow longer time for the local folks to discuss the matters and reach better and common understanding for the preservation works. We hope to gradually expend and deepen the cultural preservation works on those historical buildings. There will also be opportunity to materialize the execution of the overall city preservation and rebirth works. Summary, the main significance of this preservation is "current, local, simple, basically, multiple, variety, dynamically, continuously" which are current preservation trend.
Finally, the potential attempt of this "General Theory and an Operational Model" study is to raise up the issues for discussion on the governmental departments, their attitude of preservation toward the private rights of those historic buildings. This includes execution of limited preservation works; respect of current living cultural value being continuously evolved and developed; and holding softer attitude to deal with the rightful owners. These implications hopefully provide sufficient help for further thought while executing works on preservation planning to those historical living environments.

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The Refurbishment and Management of Aboriginal Dwellings: TheTraditional Paiwan Slabstone House

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Chun-Ta Tzeng [2]

ABSTRACT

The highly variable and unpredictable alpine climate of Taiwan's mountain region causes unstable soil conditions there. This, coupled with strong shocks of the 1999,9,21 earthquake, threatened the irreplaceable historical slabstone house sites of the prehistoric indigenous Paiwan people. The earliest Paiwanese houses are located in the central southwest portion of Taiwan's central mountain range. The call to rebuild after the calamity utilized the overall idea of community development to be shared among the Paiwanese, causing the awakening of the community's consciousness committed and devoted to looking for one's ethnic roots, as well as encouraging the Paiwanese to return and rebuild their homes.

Results from NSC97-2221-E-165-004 'To Restore and to Revitalize Aboriginal (Vernacular) Dwellings: Traditional Paiwan Slabstone House' are the basis for this research with objectives in rebuilding from their remaining slabstones and foundations, establishing a characteristic policy for housing and management, and working closely with the ecology in refurbishment methods of the slabstone house. The study will be according to the CBR (Case-Based Reasoning) and the CSBME (Code System for Building Material and Equipment) in investigating the present state of the north Paiwan slabstone house. In addition, the study uses CSBME and CBR to establish the ecological methods of refurbishment, building materials, actual construction, and provision of precise technical standards for the slabstone house's environmental management and refurbishment.

KEYWORDS

Housing Refurbishment, Slabstone House, North Paiwan, Management

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1. INTRODUCTION

The highly variable and unpredictable alpine climate of Taiwan's mountain region causes unstable soil conditions there. This, coupled with strong shocks of the 1999(921) earthquake, threatened the irreplaceable historical slabstone house sites of the prehistoric indigenous Paiwan people. Reconstruction activity following the 1999(921) quake gave little or no consideration to the preservation of the historical slabstone house. Although the 1999(921) quake served as a catalyst for rebuilding the village, the villagers lacked the technical building and managerial skills to restore the slabstone houses. Instead, they actually accelerated the deterioration and the destruction of these historical landmarks.

The project housing council's first priority for the reconstruction is to solve the Paiwanese housing problem. The secondary priority is to improve the quality of the surrounding of the Paiwanese village noted a large impact from foreign technology and modern science on Paiwanese culture. This gradually led to the loss of the Paiwanese identity as evidenced by the disappearance of the original characteristics of slabstone house. Despite many destroyed or abandoned houses in the mountain area, there still exist local enthusiasts who are committed to improving their living space maintaining traditional building methods in repairs, reconstruction even new construction. This is a notable achievement.

The purpose of this project is to develop a refurbishment model that defines creation of needed modernized living quarters while preserving the surrounding environment. Within these sustainable and environmentally conscious parameters, the definition of refurbish in this paper is not to rebuild, disassemble and remove, or even to cover the house with modern material so that it can not breathe. Refurbish here means a system of construction decreasing the amount of wasted material and effectively utilizing recycled products. This study will investigate the original ecology and past building techniques to develop sustainable designs and systems to lessen the environmental impact, and to reduce energy use. The early Paiwanese people used indestructible slabstone to construct the walls and foundations and designed their living space according to their needs in harmony with their environment. Thus, this study uses the wisdom of the early Paiwanese people as the fundamental groundwork to conduct the assessment research and develop an ecological refurbishment model.

2. RESEARCH BACKGROUND

The traditional slabstone houses of the northern Paiwanese cluster on a gentle slope of the southwest side of the central mountains. The use of the primary natural resource, slate, in these houses has come to characterize Paiwanese architecture. The 1999 (921) earthquake, local disasters, torrential rain, and resultant mudslides damaged many traditional houses. In spite of not having a proper conservation policy for these houses, the walls and foundations of many dwellings survived and represented a unique construction style.

These architectural examples also reveal to future generations the successful usage of local material to adapt to this challenging environment. The rapid economic development, periodic natural disasters, ongoing property development, and vanishing woodlands awaken the Paiwanese people’s increasing land stewardship responsibilities. This, in addition to an emotional attachment to their family lands, calls the local people to return to their homeland and restore their community. After so many catastrophes, one must be very cognizant during the restoration to not waste existing material, to be environmentally sensitive, and to retain the traditional value. If rebuilt without these considerations and massive changes in the structure and usage of non local materials; the harmonious relationship with the surrounding environment will be destroyed. This is an ideal stage to provide comforts to the Paiwanese people. There is an urgent need to provide the Paiwanese aboriginal people with modern a living space and to restore their homeland. It is the right moment to commit to the sustainable utilization of natural resources and original structure to protect the cultures of indigenous people.

The case study NSC97-2221-E-165-004 'To Restore and to Revitalize Aboriginal (Vernacular) Dwellings: Traditional Paiwanese Slabstone House' is the basis for the majority of the current research. Though an attempt to improve the Paiwanese living quality and residential safety, the case study findings were an unacceptable contrast of new modern construction applied to traditional housing structures. The current policy concentrated only on repairing the damaged roofs and unstable structures without regard to traditional local architecture. The new construction continually appears like bamboo shoots after a spring rain. Utilizing the existing foundation and bearing wall to construct a new framework covered with modern materials results in an uncomfortable living space for the original inhabitants. The current policy of conservation planning lacks continuity between areas, therefore, this study recommends a thorough investigation and assessment to develop a systematic approach to evaluate and refurbish Paiwanese dwellings.

State policy regarding these valuable houses lacks a united plan to demolish or refurbish the few surviving traditional slabstone houses. Utilizing local materials should reduce the amount of time necessary to rebuild as well as increase the comfort level of the elderly within their familiar surroundings. The ideal refurbishment should utilize the existing site, use any viable surviving walls and foundation, address modern living demands and improve the quality of the surrounding environment, while retaining its valuable and unique architectural style.

3. RESEARCH METHOD

There were 38,935 collapsed houses and 45,320 damaged houses resulting from the (921) earthquake. The (921) earthquake caused tremendous social problems and massive construction demands. 23 aboriginal villages were reconstructed, 17 projects utilized local materials. These 17 projects were part of a united overall community conservation plan that allowed residents to participate at a grassroots level. Many of the younger generation, recognizing the traditional value of their unique dwellings, returned to their villages to assist in the rebuilding and reconstruction of the slabstone housing. Particularly exciting is the creation of several modern slabstone architectural buildings utilizing traditional construction in the mountain area.

This research arranges the slabstone houses of the North Paiwanese into three categories:
(1) Areas where the village and residents have never been relocated such as Wu-tai.
(2) Areas where the village and residents have been relocated to a new area and they continue to live there such as Da-lai, Fa-wan , Chi-ka.
(3) Area where residents have been relocated but, are currently abandoned such as Tai-wu, Li-lee, Lai-yi.

The research tasks are as follows:
(1) Investigate the North Paiwan environment, collect information about the relationship between the surrounding environment and the existing slabstone houses, and establish standards for a refurbishment model that best coordinates the villages' unique architectural style, transportation needs, geographical location and surrounding eco-system.
(2) Evaluate the currently completed slabstone houses. In order to create an efficient management model capable of analyzing the variable degree of the refurbishment projects, it is necessary to collect information regarding village location, quantity of houses rebuilt, changes in the original structures, and the adaptation of the living space to meet needs of the inhabitants.

The management of aboriginal dwellings will focus on the enhancement of the quality of the living space and how to simultaneously preserve the ethnic, cultural, and ecological characteristics of the village site. The refurbishment process needs to consider North Paiwan's ecosystem, which uses primitive materials and traditional construction methods. The slabstone is a most unique primitive material and it is used in the construction of the bearing wall, which supports the main structure of house. The massiveness and durability of the slabstone will sustain the tradition dwelling and original character forever. Regarding the structure of the slabstone house, each outer wall of the dwelling is 60 cm to 100cm thick. If the slabstone can be perfectly constructed, the slabstone house will be able to endure the weight of any newly designed roof. By overlapping the slabstones, the house becomes more energy efficient because the house is well insulated by the slabstone. The thickness of the slabstone wall allows the interior newly-built walls to flawlessly coexist with the outer wall. The structure of dual wall efficiently retains heat and ventilates humidity, which is the perfect energy-saving structure for mountain area provinces, and is also environmentally friendly. The material and structure of the slabstone house are important factors relative to the ecological environment and are also used in recycling unwanted waste material from the social environment, which benefits the ecosystem.

Therefore, this research will address the continuity of Paiwanese architectural integrity through the study of ecological refurbishment. To successfully refurbish the Paiwanese dwellings, the slabstone must be efficiently used to support the bearing wall and this study will propose enhancement of the standard of the architectural function assessment for the future development projects. According to 'Construction Material and Equipment Classification' in CSBME (Code System for Building Material and Equipments) the construction materials and framework of Paiwanese slabstone dwellings can be categorized by: existing slabstone houses, the relocated village positions, the quantity of housing, the degree of destruction of slabstone houses, and evaluation of adaptation for the modern living space. In addition, CBR (Case-based Reasoning) will guide the development plan for the various regional slabstone houses for suitability and durability. The study will analyze the CBR data and the results of each case and then propose a more complete solution for the refurbishment model.

4. CODE SYSTEM FOR BUILDING MATERIAL AND EQUIPMENTS ANALYSIS (CSBME)

By utilizing the existing field study data and the CSBME (CODE SYSTEM FOR BUILDING MATERIAL AND EQUIPMENTS ANALYSIS), the structures of slabstone houses are grouped into the following categories:

GroupA: The main structure and façade maintains its traditional slabstone characteristics but the interior partitions of the secondary structure reinforced with steel frame, thus increasing the living area space. Currently these dwelling are non-inhabited and not for private use.

Group B: The main structure maintains its traditional slabstone characteristics with slight changes on the outside façade, but the secondary structure is replaced with different materials and structure; decorative structure utilizes modern wooden window casings and a metal main entry door.

Group C: The main structure is replaced with steel or brick, which increases the interior space for multi-purpose use. The secondary structure is replaced by different materials and construction. The decorative structure is completely replaced by using modern wooden window casings and a metal main entry door.

Group D: The main structure is replaced with different building materials and non traditional design. The secondary structure is replaced by different materials and construction. The decoration structure is completely remodeled using modern windows and a metal entry door.

Group E: The main structure is incomplete. The secondary and decorative structure has been destroyed

Group F: The main structure is incompleted, but, however, parts of the foundation and wall segments still exist.

According to the CSBME assessment, this study will review the feasibility of the refurbishment model. The refurbishment model will be based on the guidelines of the sustainable housing development concepts, "Ecology, Nature, No Mortar", and use traditional building materials and methods. Based on the concept of "Reuse", the study proposes an easier and more manageable refurbishment model that the government should take to meet their commitment to sustainable development for Paiwanese people. Below is a list of different types of slabstone dwellings.

4.1 AREAS HAVE NEVER BEEN RELOCATED SUCH AS WU-TAI.

Table 1. Rebuild flagstone houses

Group D ：Wu-tai	
	
Main structural ：bearing wall combine slabstone and concrete structure.	Main structural ：bearing wall combine slabstone and concrete structure.
Secondary structure：steel frame, lay roofing slabstone.	Secondary structure ：steel frame, lay roofing slabstone.
Decoration structure：steel sash, wood board.	Decoration structure ：steel sash,wood board.

4.2 AREAS HAVE BEEN RELOCATED AND CONTINUE TO LIVE SUCH AS DA-LAI, FA-WAN , CHI-KA.

Table 2. Repaired slabstone houses and Refurbish slabstone houses

Group C: Da-lai	
	
Main structural：slabstone of bearing wall, steel structure.	Main structural：slabstone of bearing wall, brick wall with cement.
Secondary structure：steel frame, lay roofing slabstone.	Secondary structure： lay roofing slabstone.
	Decoration structure： frame for fittings.
Group D ：Fa-wam	
	
Main structural：steel frame, wooden bean.	Main structural：concrete structure, wooden bean.
Secondary structure：wood studding, tin roofing, tinplate wall.	Secondary structure：wood studding, tember partition, lay roofing board.
Decoration structure： frame for fittings.	Decoration structure： frame for fittings.
Group A ：Chi-ka	
	
Main structural：slabstone of bearing wall, wooden bean.	Main structural：slabstone of bearing wall, wooden bean.
Secondary structure：lay roofing board, lay roofing slabstone, wood siding wall.	Secondary structure：lay roofing board, lay roofing slabstone, stand up front wall.

4.3 AREAS HAVE BEEN RELOCATED BUT ABANDONED SUCH AS TAI-WU, LI-LEE, LAI-YI.

Table 3. Repaired slabstone houses and Refurbish slabstone houses

Group A ：Tai-wu	
	
Main structural：slabstone of bearing wall, wooden bean.	Main structural：concrete structure with slabstone, wooden bean.
Secondary structure：lay roofing board, lay roofing slabstone, stand up front wall.	Secondary structure：wood studding, tember partition, lay roofing board.
Decoration structure： frame for fittings. steel sash.	Decoration structure： frame for fittings. steel sash.
Group B ：Li-lee	
	
Main structural：slabstone of bearing wall, wooden bean.	Main structural：slabstone of bearing wall, wooden bean.
Secondary structure：wood studding, tin roofing, banboo purlin.	Secondary structure：wood studding, tin roofing, banboo purlin.
Decoration structure：frame for fittings, steel sash.	Decoration structure：frame for fittings, steel sash.
Group A, Group F:：Lai-yi	
	
Main structural：slabstone of bearing wall, wooden bean.	Main structural：slabstone of bearing wall, wooden bean.
Secondary structure：lay roofing board, lay roofing slabstone, stand up front wall.	Secondary structure：stand up front wall.
Decoration structure：lay slabstone flooring,	

5. ACCORDING TO THE CBR (CASE-BASED REASONING) ANALYSIS

Following the categorization in the CSBME, the study relies on the refurbishment model to restore the existing slabstone houses. According to the flow chart, the study will collect the field data, compile statistics, determine the original housing construction system, and search for similar cases to find the proposed solution. The assessment of the refurbishment model for the aboriginal dwelling must be based on the original construction system and the changes of the past construction styles to establish a guideline for future projects.

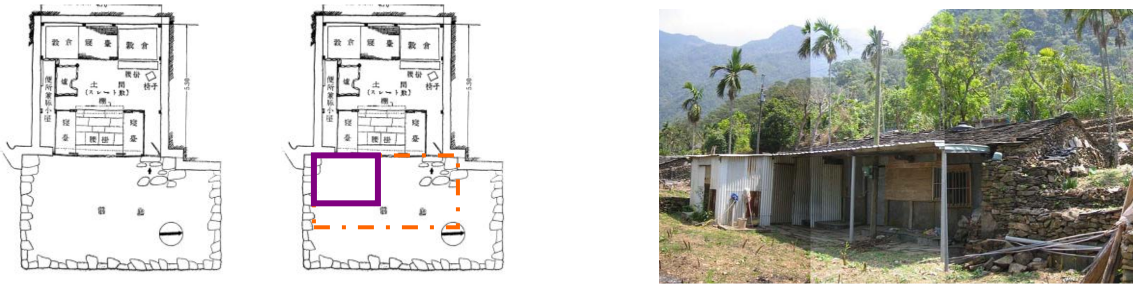

Figure 1: *The process of refurbishing slabstone houses*

Retrieve: From the existing slabstone site, the village transformation, and the field study data material shows that in the Ma Chia Village, new migrants and old residents exist together in one location whereas typical villages are segregated into living areas based on the amount of time residing in that community. The land from the old village originally belonged to the aboriginal people and was transferred into a national owned special group collective property (before the Japanese Occupation, during the Japanese Occupation, and after the KMT retreat) to be transferred into private property then returned to the original aboriginal owners or publicly owned by the town center or partially owned by the village. Due to transportation issues, the aboriginals find it difficult to manage their property and are often willing to forfeit their property. This study tries to categorize village conditions to search for similar case studies. The villages were categorized into three groups.

1. Areas where the village and its residents have not been relocated. Chi-Ka Village has a unique terrain, a self contained ecosystem, untouched natural resources, and limited government influence regarding living quality improvements on safety reinforcement and village safety policy. To restore the Chi-Ka Village is truly to return to its original culture and lifestyle.
2. Areas where the village and residents have been relocated and continue to live. The culture of the old Dai Lai Village was influenced by previous foreign occupation and still offers a self sufficient agricultural lifestyle. The utilization of natural resources is continually expanded thus stimulating economic activity and developing a tourism business to evoke the spirit of the aboriginal culture. The old Fa Wan and old Dai Lai village both show tremendous improvement as result of the government guidance upon living quality, village safety, and community planning. Ma Chia village combines the old and new village styles. The relationship of the economically and socially intertwined villages of Ma Chia and Fa Wan is reflected in their remodeling construction work in which the old and new structures coexist side by side.
3. Areas where residents have been relocated and are currently abandoned. From the study, the majority of the mountainous slabstone sites have been deserted and the agricultural land is depleted. The nature resources are unused and the old village has ceased to exist while the site is being reclaimed by nature.

Reuse: The reuse of sustainable refurbishment is based on the assessment of the village study. For example, in old Chi-Ka Village (where the residents have never been relocated), there is a close relationship between the existing slabstone houses and their surrounding environment. The village residents still maintain a self contained village agricultural lifestyle. The area has never been developed, which is a key element to a successful sustainable refurbishment model. Both Old Dai Lai and Fa Wan Villages have a smattering of returning villagers, who resume their agricultural lifestyles and repair their ancestral homes. The entire village maintenance is shouldered by the few returning villagers. Relocated and continue to live there in MaChia Village the original village style is invaded by overzealous and unplanned development. This village's sustainable model should be based on moderate and controlled development principles. The areas where residents have been relocated are currently deserted. This current study is concentrated on Tai Wu, Li Lee, and Lai Yi villages; these villages are deserted because of the treacherous transportation routes that must be used to access these area. The dilemma of reusing these sites in the future will be complicated by these continuous transportation problems. However, old Li Lee's pristine condition makes it an ideal case study for the conservation of the natural environment with controlled development.

Revise: The revision process enables problem solving by adjusting or modifying previous solutions. For a successful refurbishment five critical areas must be addressed. These are the sustainability of slabstone housing, geographical site location, quantity of remodeled houses in that area, stage of building development, and adaptation for the client's changing space needs. The realistic goal of sustainable slabstone housing must achieve a modern living standard and maintain appropriate living space dimensions. In addition, the key components to a complete refurbishment model will also need to include the assessment of the existing slabstone houses' structure, the scrutiny and analysis of the collected field study data and the contingent plan upon the various local conditions.

Retain: Confirm the new solution and add to the cumulative database for use in future projects. The success of sustainability in the refurbishment project depends on how well the material and structure are combined. The unique construction system of the North Paiwanese slabstone house can be divided into two different structure systems. The first system is the overlapping stacks system, which is ordered by the main structure first, followed by the secondary structure, and then followed by the decorative structure. This kind of refurbishment model will differ if using the one part integration system. Regarding to utilize construction materials, the combination of local slabstone and timber is able to reveal massiveness of the primary feature. This can perfectly achieve the balance of the structure and material.

Figure 2: *The process of refurbish slabstone houses*

6. CONCLUSION AND SUGGESTION

This study investigates and develops a refurbishment management model that concentrates on the three major categories of slabstone houses delineated earlier in the Research Method. In an attempt to establish a workable refurbishment model, this research includes field studies, interviews, and the compilation and analysis of existing village construction data including information regarding existing slabstone house structures. By examining the relationship between social and cultural perspectives as well as the environmental impact of slabstone, this study strives to create a systematic refurbishment management model.

6.1 Cultural and Social Perspective

New housing construction attempts to coordinate current needs with the government's aboriginal sustainability development project. The governmental guidelines regarding the reuse of the village site and the slabstone housing is incomplete thus hampering the successful completion of village reconstruction as well as dampening the community's enthusiasm for the entire project. According to the study results, the abandoned village Lai-Yi consists of 200 slabstone houses which have been carefully protected by preservationists of traditional culture and aboriginal policy. Using metal doors and stone fencing to isolate the old village site while effectively preserving the slabstone houses for the next generation, raises questions about the purpose of the preservation. The village chief and some of the villagers intend to turn old Lai-Yi into a tourist destination using government development funds to restore some of the slabstone houses so that tourists can experience the culture and a way of life from a past era. Enclosing the remaining slabstone sites prevent further destruction or removal of slabstone. Some of relocated villagers move their ancestral homes' construction materials piece by piece to rebuild and to live in a traditional slabstone house structure in close proximity to modern housing.

One of the cases from the field study concerns villagers relocated to Da Lai where access to their homes is contingent upon bridges. Due to the ability to limit access to the mountain area, the village environment can return to its pristine state unsoiled by excessive human influence. Another case concerns Fa-wan village, one member of the "Paiwanese Development association," Mr. Yuan, reconstructed his ancestors' house and upgraded the interior structure with modern facilities turning the old slabstone house into an inhabitable but incongruent space. Lack of a definitive refurbishment standard led to many people following Mr. Yuan's example (i.e. metal door and the use of concrete on the slabstone) which resulted in a colony of newly rebuilt houses discordant with the surrounding village. Like bamboo shooting up after a spring shower, these rebuilt houses continue to proliferate.

In summary, the findings based on the social and cultural factors of our field investigations are:

1. Villagers still residing in original slabstone houses as a result of either never relocating or relocating to other traditional slabstone houses seem to increase their cultural awareness and the importance of preserving their ethnic identity. These villagers tend to restore their slabstone houses using modern building techniques and materials to produce a functional space. However, the concept to "Reuse" the old slabstone site must further be joined with the refurbishment management process in order to obtain a product that brings the old traditional spirit and values into the new living space.
2. There are two situations resulting from uninhabited dwellings. In the first situation, there has been no effort to preserve the existing slabstone houses thus they are quickly dilapidated. In the second situation, there is a tendency to overprotect the abandoned slabstone dwellings resulting in the slabstone coexisting with the natural environment. Since the dwellings are uninhabited, maintenance management is difficult resulting in secondary damage although extreme preservation measures have been taken, therefore, further evaluation of this preservation policy is recommended as the natural environment is reclaiming the site.

6.2 Sustainable Management of the Ecosystems

A key characteristic of slabstone dwellings is the utilization of the following locally available materials: timber cut from nearby mountains, vegetation grown to stem soil erosion, and slabstone naturally formed by wind and years of rainfall. When a large piece of rock falls from the mountain, it is broken into smaller pieces, which the local people can use for construction. Nowadays, the village ecosystem is unable to meet the demand for slabstone thus the restoration has two problems. First, there is a shortage of natural materials, which includes natural stone and wood. Secondly, the skills needed to craft the slabstone and local timbers are severely limited because the localized construction knowledge is rarely passed down to the younger generation. In one of the case studies, village chief Hong and local villager Mr. Shin, both reconstructed houses by using their old slabstone materials and purchasing additional slabstone from their villagers. Recognizing the value of the slabstone, the villagers secure their remaining slabstone with metal wires.

Regarding the construction material, the use of natural and local resources is advantageous to local architects. The slabstone and mountain timber are more accessible and their use may eliminate some of the common labor and transportation problems found on most construction sites. These materials also provide adequate protection against the mountain climate and terrain. To support the weight of the main structure and create an interlocking horizontal and vertical structure, the traditional construction method utilizes a variety of different sized slabstone in both the main and secondary structure. In the secondary structure, especially in abandoned houses, the wooden horizontal roof beam and the wooden framework are prone to rot. Also, the decorative structure is typically an easily replaced wooden material. The proposed refurbishment model should dictate the replacement of the easily damaged wooden material with light weight steel or reusable material, especially in one spam beam houses. It can reinforce the one part formation and gravities of the slabstone to fit the requirements of the stability. It is very urgent to establish a refurbishment management model that will stress the importance of meeting the need of safety issue.

The refurbishment management model must take into account the structure as well as the materials utilized in the slabstone house in order to maintain the ecosystem’s natural cycle. Some goals of a successful refurbishment management model are:
1. To have the minimal environmental impact and to reduce the new material usage by reusing existing material or recycled material.
2. To reduce the amount of building material by maximizing efficiency through the use of natural resources, especially to insulate and control ambient temperature.
3. To extend the life span of slabstone of houses by avoiding additional demolishment of buildings, choosing the least invasive modifications, or doing partial remodeling.

7. LITERATURE

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SECTION 4

EMERGENT MANAGEMENT PARADIGMS IN ARCHITECTURAL MANAGEMENT

Numerical Studies on Emergency Ventilation System in Public Transport Interchanges

Lu Qu [1]
Wan-Ki Chow [2]

ABSTRACT

Public Transport Interchanges are built to facilitate different transport in high density cities. Smoke is identified to be a hazard as smoke obscuration will make some egress unusable. This paper aims to evaluate the performance of emergency ventilation system in an example public transport interchange including subway station and bus terminal. Luggage fire on platform with different ventilation operations are simulated numerically to identify if there is a tenable environment for the evacuation of passengers. Computational fluid dynamics model - Fire Dynamics Simulator (FDS V5) is used to predict smoke spread and the available safe egress time during the fire. It is demonstrated that luggage fire on platform can cause serious consequence if the emergency ventilation system is not operating normally. Mechanical ventilation system can be useful in delaying the spread of fire and smoke, while the smoke impacts the evacuation egress in a short time and the smoke obscuration will make some egress unusable and thus prolong the evacuation time. It shows that appropriate incorporation of fire and smoke effects is important in the evaluation of evacuation.

KEYWORDS

Public transport interchanges, Emergency ventilation, Smoke control, Computational fluid dynamics

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1. INTRODUCTION

Public Transport Interchanges (PTIs) are built to facilitate different transport means in high density cities. Typical PTIs are usually provided at town centres or other regional focal points where passengers interchange between rail, buses, taxis and private vehicles from underground to above ground level. Fire safety is a deep concern and specific problems for PTIs include at least the following three aspects [Qu & Chow 2008]:

- Difficulties in evacuating the high occupant loading during peak hours;
- Fire hazard in different fire sources;
- Long evacuation time due to the long travel distance underground.

Indoor environment of PTIs is different from that of other buildings above ground. Even when a small fire occurs, large quantity of smoke will be generated and might spread to the evacuation routes. The environment could become untenable within a short time. Passengers are exposed to high volume of smoke risks during evacuation. Smoke control systems are therefore necessary in PTIs.

This paper aims to simulate luggage fire on platform with different ventilation operations to identify if there is a tenable environment for the evacuation of passengers. Computational fluid dynamics model - Fire Dynamics Simulator (FDS V5) is used to predict smoke spread and the available safe egress time during the fire.

2. EMERGENCY VENTILATION SYSTEM

Mechanical ventilation system is very important in PTIs especially for the enclosed facilities like subway and bus terminals. It is considered to be the main approach for smoke control and fire safety in PTIs. Fires inside of vehicles are almost always the largest fires that need to be considered [Till 2006]. The early suppression provided by sprinklers may impact smoke layering and shorten the available evacuation time.

The mechanical emergency ventilation system shall make provisions for the protection of passengers, employees, and emergency personnel from fire and smoke during a fire emergency and shall be designed to maintain the required airflow rates for a minimum of 1 hour but not less than the anticipated evacuation time [National Fire Protection Association 2007].

For subway stations in some countries, the mechanical air-conditioning and ventilation system might be integrated with the smoke exhaust for keeping passengers safe during a fire emergency. The mechanical ventilation uses either the platform smoke exhaust, or the tunnel ventilation system.

For the stations in a PTI with relatively complicated design, tenability should be achieved for extended periods. Due to the increased volumes of smoke, larger design fires will require a much larger smoke control system to achieve extended periods of tenability.

3. NUMERICAL SIMULATIONS

Computational fluid dynamics (CFD) techniques have been used in engineering analysis of the ventilation system in fire scenarios for many years. Fire Dynamics Simulator (FDS) Version 5.1 developed by the National Institute of Standards and Technology in U.S.A. has been used to study fires in large halls [Chow *et al.* 2007], car parks [Lin *et al.* 2008] and subway stations [Jae *et al.* 2009]. Different fire scenarios like enclosed space fires and fires under ventilation, etc. have been studied. In this study, the performance of smoke control system in a PTI in Hong Kong is investigated by simulating the heat and smoke propagation phenomena in the PTI.

The model evaluates smoke visibility based on line of sight. The importance of visibility as a line integral has been demonstrated in a compartment fire under natural ventilation and an underground rail station fire under both natural ventilation and mechanical ventilation conditions [Kang 2007]. The smoke model provides a possibility for direct comparison of numerical and experimental results [Li & Chow 2008].

Performance of emergency ventilation system under train fire in a PTI has been studied by numerical method [Qu & Chow 2009]. It demonstrates that the smoke impacts the evacuation egress in a short time and the smoke obscuration will make some egress unusable and thus prolong the evacuation time.

4. AN EXAMPLE PUBLIC TRANSPORT INTERCHANGE

The PTI chosen for this study is assumed to represent a typical PTI with underground subway and ground bus terminal. The PTI includes two levels as shown in Fig. 1.

The cross section is shown in Fig. 1 with two tracks on either side of the platform. The total length of PTI is 180 m and the platform is 20 m wide. There are four stairs on each platform and 40 platform doors are located on both sides of platform as shown in Fig. 2. The layout of platform 2 is similar to platform 1. The concourse is about 20 m wide. There are one bus station and one car park on each side of the concourse. A sectional view is shown in Fig. 1.

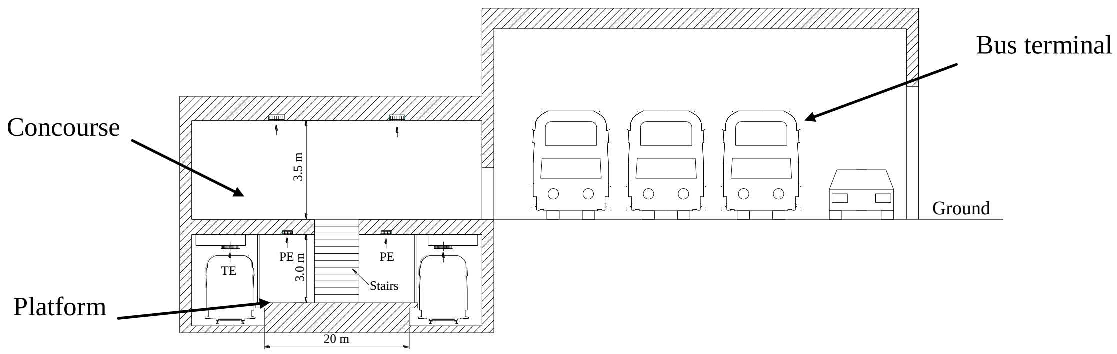
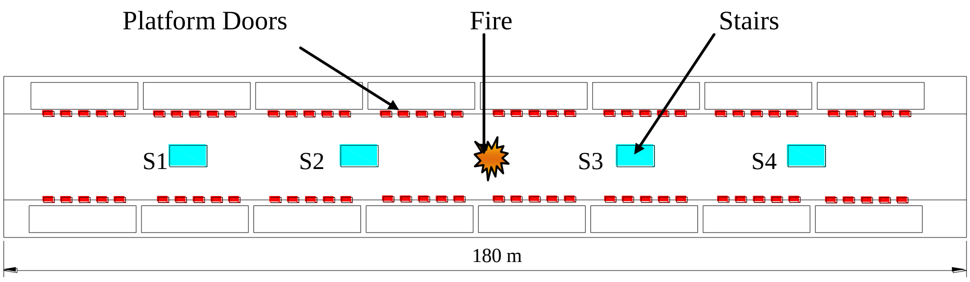


Figure 1: *Sectional view of the public transport interchange.*

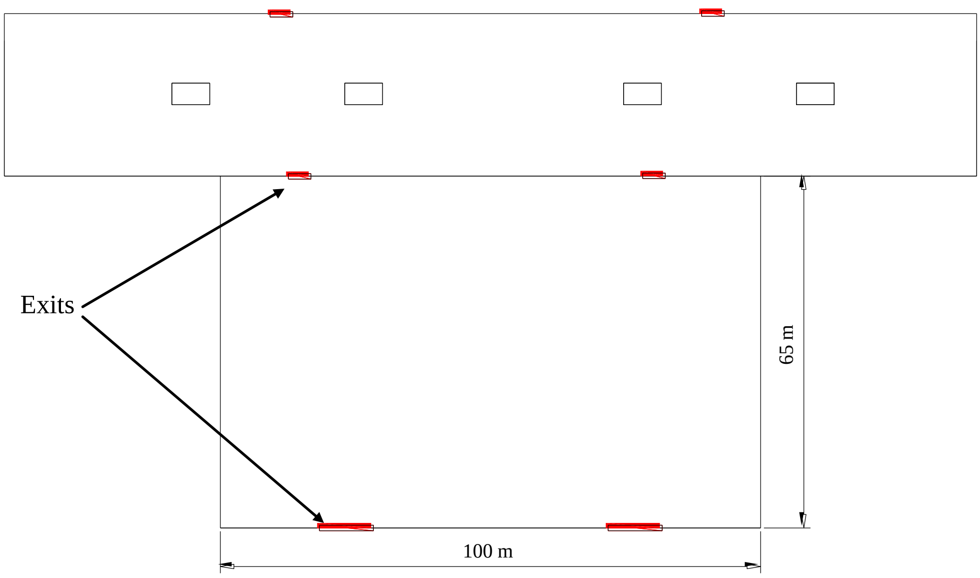
5. FIRE SCENARIOS

The fire is assumed to be a luggage fire in the middle of platform. For simplicity, no vertical gradient along a platform is assumed. As the incident place is close to the two platform stairs, S2 and S3, the smoke could simultaneously affect these two stairs on platform. The combustibles used are plastics and foam, the same type of fuel as used in the compartment fire [McGrattan *et al.* 2008]. The exhaust vents are modeled as mass flow boundaries with specified velocity. The exits for vehicles and for pedestrians are specified to have zero static pressure boundaries. There are no other thermal sources other than the fire itself.

The platform exhaust is indicated by the line segment on the ceiling, marked PE (platform exhaust) and the tunnel exhaust is indicated by the vents in the tracks, marked TE (tunnel exhaust) as shown in Fig. 1. The maximum exhaust rate attainable is 90 m^3/s for each floor level [GB-50517 2003]. This is the so-called ‘all-exhaust’ mode of ventilation. These ventilation rates are implemented in the CFD model as time-dependent velocity boundaries. Both natural ventilation and mechanical ventilation are considered for smoke control. Mechanical ventilation uses either the platform smoke exhaust or the tunnel ventilation system. The smoke spread under both natural ventilation and mechanical ventilation are evaluated separately. Under mechanical ventilation, the smoke exhaust system is started 60 s after the fire [National Fire Protection Association 2007].



(a) Platform floor



(b) Ground floor

Figure 2: *Plan of the public transport interchange.*

Three simulation cases are set for this study. Case 1 is set as reference case, where there is no operation of ventilation systems. Cases 2 and 3 represent different operations of ventilation system. The specified conditions above are summarized in Table 2. Since the fire source of platform is assumed to be passenger luggage or rubbish bin, simulating fire size of 2 MW stands for the design fire size of platform and concourse fire.

Table 2: Ventilation operations of simulation

Case 1	No mechanical ventilation
Case 2	Platform exhaust system, platform doors closed
Case 3	Platform exhaust system and tunnel exhaust system, platform doors open

6. SMOKE DISPERSION

Mechanical ventilation of the exhaust model is used to investigate if the evacuation route will be tenable in the fire. Smoke dispersion on the platform and concourse in the three cases is shown in Fig. 3 to Fig. 5. It demonstrates the exhaust extraction can be useful in delaying the spread of fire and smoke. In Case 1, smoke already spreads to some part of the platform in 60 s and spreads to nearly the entire concourse at about 240 s. Smoke has spread to the bus terminal at about 100 s, then almost the entire subway station is filled with smoke at 600 s. In Case 2 and Case 3 with operation of ventilation, smoke spreads rather slowly. It indicates that ventilation system is effective in gaining available time for evacuation time. The smoke and fire spread relatively late into the occupied zone at about 6 min, but it affects the stairs S2 and S3 in the first 1 min. The smoke blocks the way from platform doors to stairs near to the fire in the first 2 min, which will give difficulty to train evacuation.

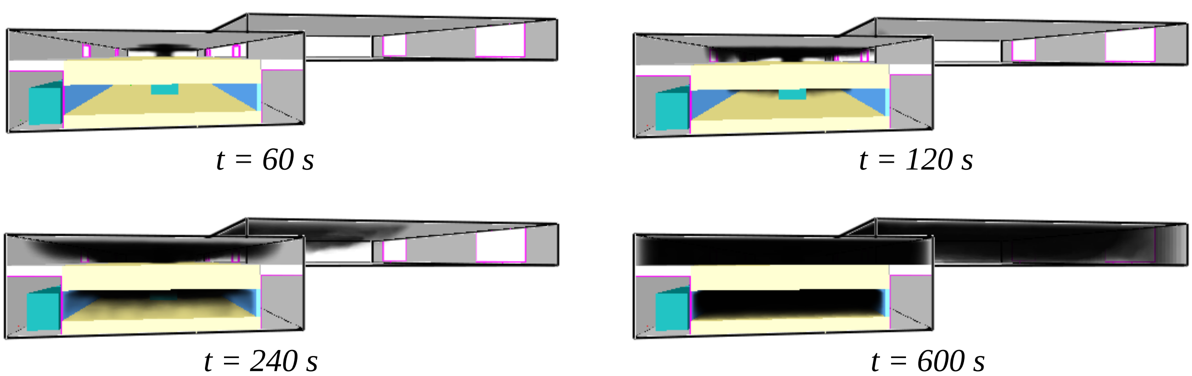


Figure 3: *Smoke dispersion in Case 1.*

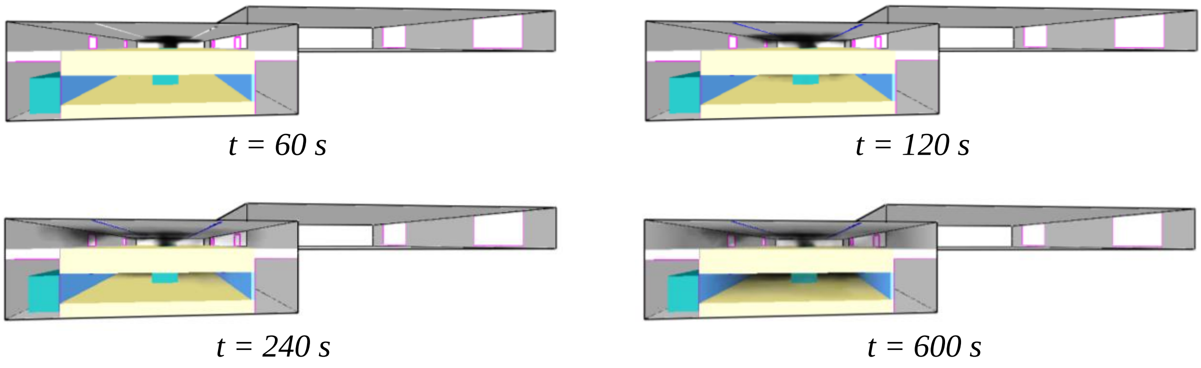


Figure 4: *Smoke dispersion in Case 2.*

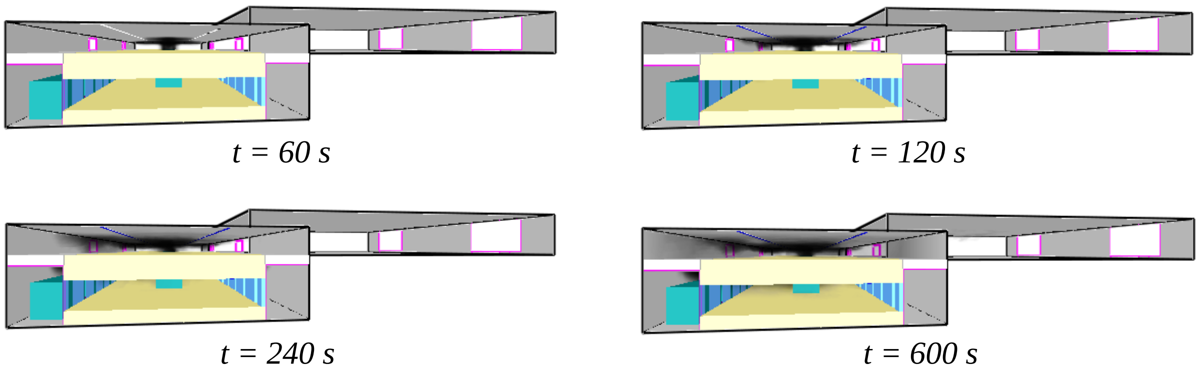


Figure 5: *Smoke dispersion in Case 3.*

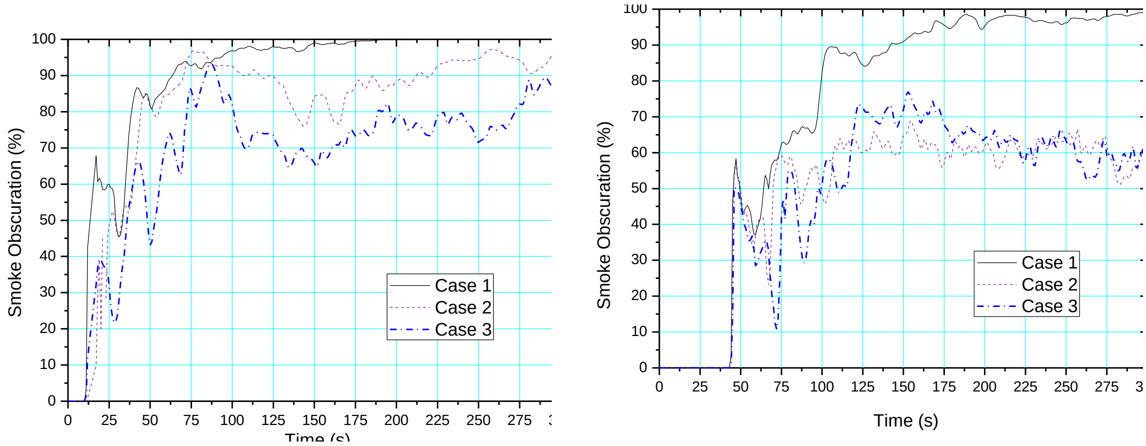
7. VISIBITLITY CONDITION

Smoke spread in the modeled PTI is investigated by using transient visibility because visibility is the most important factor in estimating the time to reach untenable condition. Visibility on the platform door to stair is investigated in this study. The main evacuation path is set as route at 1.5 m above platform, which is about the person's eye height. To describe the optical obscuration, a beam detector is used at the endpoints of a light beam. The total percentage of obscuration [McGrattan *et al.* 2008] at which the detector activates in terms of response is given by:

$$\text{Obscuration} = \left(1 - \exp\left(-\alpha_m \sum_{i=1}^{N} \rho_{soot,i} \Delta x_i\right)\right) \times 100\% \tag{1}$$

where i is a mesh cell along the path of the beam, $\rho_{soot,i}$ is the soot density of the mesh cell, and Δx_i is the distance within the mesh cell that is traversed by the beam.

Fig. 6 shows the smoke obscuration from middle platform door to the nearest stair S2 on platform level. In contrast with Case 1, smoke spread to middle part of the platform at about 75 s. The smoke obscuration reached 90% at about 100 s and it did not increase then because of the effect of ventilation system. Fig. 7 shows the smoke obscuration from stair S2 to the nearest exit on concourse level. It can be seen that there is only little smoke near the fire source by approximately 100 s. Because of ventilation, the smoke obscuration is not very high in Case 2 and Case 3 on concourse level. By comparing the three cases, it may be said that ventilation is effective to give capacity for passenger's fire safety to maintain a safe evacuation path, and both ventilation operations can achieve similar performance.



(a) Platform level *(b) Concourse level*

Figure 6: *Smoke obscuration under different ventilation*

Smoke obscuration from platform doors to four stairs in Case 3 is shown in Fig 6. It demonstrates that stairs S2 and S3 close to the fire source are blocked by smoke in the first 100 s. The times taken for smoke to reach 90% obscuration for S2 and S3 are 289 s and 314 s respectively, and the other two stairs with relatively low smoke obscuration. Comparing these times indicates that half of the stairs on platform will be blocked by smoke at about 5 min after fire occurs, it will prolong the evacuation time.

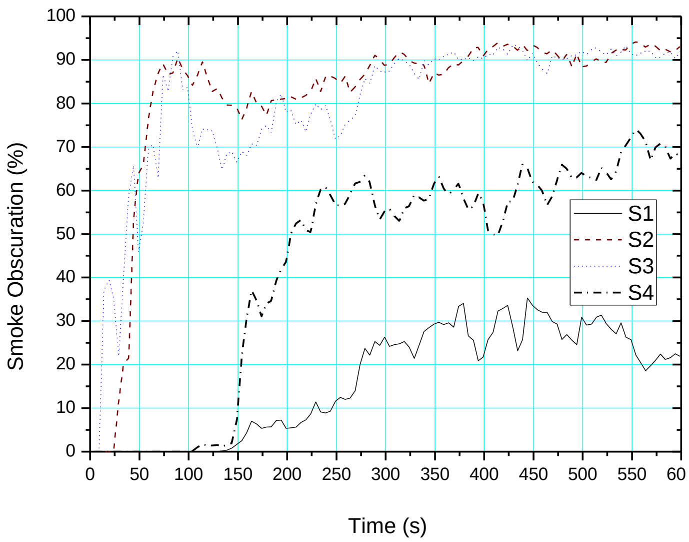


Figure 7: *Smoke obscuration to stairs in Case 3*

As the PTI is open to public, many people moving through these subterranean enclosures and elevated structures compound the life safety dangers. Passengers flow can be very large during peak hours though very low in most of the time. As surveyed during morning peak hours in Hong Kong, 8-car trains with a capacity of 2,500 passengers will run at 2.1 minute intervals. The loading can be up to 70,000 passengers per hour per direction and passenger flow can reach 40,000 per hour in one station [Hong Kong MTR homepage 2008]. For emergency evacuation, the occupants should be evacuated to a safe place within a certain time [National Fire Protection Association 2007]. For PTIs, it needs to determine that tenability can be achieved for extended periods.

From the above CFD simulated results, although the Emergency Ventilation can be useful in delaying the spread of fire and smoke, smoke will impact the evacuation egress in a short time. Although luggage fire is not serious as the train fire [Qu & Chow 2009] some egresses became unavailable quickly because the fire source may be closed to those egresses. If the fire occurs in rush hours and full evacuation of train needs to be considered, smoke obscuration will make some egress unusable and prolong the evacuation time.

9. CONCLUSION

In this paper, the CFD model FDS is used to simulate the heat and smoke propagation phenomena in a PTI. The environment under design fire scenario is studied and the performance of the smoke control system is evaluated. The following conclusion can be summarized from this study:

- Even a luggage fire on platform can cause serious consequence if the emergency ventilation system is not operating normally.
- The passengers in platform with effective emergency ventilation system have more than 300 s available time for evacuation.
- Tunnel exhaust system can assist the platform exhaust system to maintain acceptable enviroment in platform fire.
- Mechanical ventilation system can be useful in delaying the spread of fire and smoke, while the smoke impacts the evacuation egress in a short time and the smoke obscuration will make some egress unusable and thus prolong the evacuation time.
- It shows that appropriate incorporation of fire and smoke effects is important in the evaluation of evacuation.

According to the high occupant loading during peak hours and long travel distance underground in Hong Kong's PTIs, the plan of emergency evacuation during fire needs to be proposed carefully. Fire hazard in different fire sources and evacuation time in PTIs will be studied in the future.

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Habitus shock: a model for architect-client relationships on house projects based on sociological and psychological perspectives

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Kerry London [2]

ABSTRACT

The widening gap between architects and clients and the associated problems in the management of their relationship have long been recognised by practitioners and researchers alike. An emerging trend in recent studies is to develop descriptive models to describe behavioural characteristics of relationships based on observations of 'real world' practice, indicating the significance of understanding the complexities of the social environment in which the architect-client relationship is within. This research built upon the work of past descriptive models by exploring the architect-client relationship on house projects with a focus on the client's voice. It is an interdisciplinary study drawing theory from sociology to further understand this built environment industry problem. Sixty-nine percent of architects in Australia spend some of their work time on house projects and therefore improvements in this area can have significant impact on a considerably large portion of the profession. *Habitus* theory borrowed from sociology explains that the nature of architecture as a specialised activity places architects within an *architectural habitus*, distinguishing them from clients who are not trained in the field. An underlying premise of this study is that a mismatch between the architect and client's habituses occurs as they enter into a relationship on the house project. This phenomenon is termed *habitus shock*, referring to the client's experience of disorientation as they are confronted with an unfamiliar architectural habitus on the project. Culture shock theory is examined for its contribution to explain the process to which the client adjusts to the unfamiliar environment during habitus shock. The habitus shock model proposed in this paper suggests that the client may achieve learning during habitus shock and it is this client learning that can lead to successful relationships.

KEYWORDS

Architect-client relationships, architectural milieu, house projects, client behaviour

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1. INTRODUCTION

Architects achieve their objectives, whatever these may be, through client work (RIBA, 1993). Excellent design is meaningless unless understood, recognised and endorsed by clients who are ultimately in the power to fund projects. The nature and quality of the interface between architects and clients is therefore of central importance to the success of the architectural profession and is “one single, critically important, working relationship that rivets the attention day by day, week by week, of all practicing architects” (RIBA, 1995, p.1).

The extent to which the architect’s contribution is valued has, however, become increasingly questionable with a growing number of dissatisfied clients as past studies have shown (RIBA, 1992, 1993, 1995). Clients are becoming increasingly critical in seeking ways of procuring buildings and are no longer content to rely on architects as the primary adviser (RIBA, 1992; Nicol & Pilling, 2000). A radical change in the manner in which architects deal with clients is required if architects are to maintain their position within the industry. The profession’s habits of “exclusivism” and “protectionism” need to be eradicated in order to communicate more clearly the contribution they can make to the quality of the built environment (Cuff, 1991; RIBA, 1993). While design skills are not exclusive to the architectural profession, architects, by virtue of their training and specialisation are in a central position to apply appropriate knowledge and judgment to decisions on projects (RIBA, 1992). The marginalisation of the profession can therefore be detrimental to the quality of the environment.

This theoretical paper proposes a descriptive model for successful architect-client relationships on house projects focussing on the client’s voice. The applicability of sociological and psychological concepts is explored to further understand this built environment industry problem. It provides an account of how the architectural profession’s endeavour to maintain social distinction and autonomy by creating silent boundaries around itself has led to an increased distancing of the architectural community from clients who are not trained as professional architects. Several questions therefore arise: To what extent can the boundaries between architects and clients be blurred? What is about some relationships that is an enabler for success and how does this differ from other less successful relationships? Are there characteristics that underpin successful relationships and what are they?

Although the study is limited to architect-client relationships on house projects, it is nonetheless an important area of study as it represents a significant portion of the type of work architects are regularly involved with. Sixty-nine percent of architects in Australia indicate that they spend some of their work time on house projects including alterations, additions and new projects (RAIA, 1998). Furthermore, sole practitioners and small firms with five or less staff are a prominent feature in how architecture is practiced in Australia (RAIA, 2006). Additionally, the most frequent client type for sole practitioners and small firms are individuals who seek architectural services on residential properties (RAIA, 2006). Existing strategies, tools and techniques developed to manage relationships, which are typically aimed at larger projects and teams (for eg. Salisbury, 1991; Kamara et al, 1999) may not translate easily to the average architect and their relationship with the client. Therefore this study concerned with the architect practicing as a sole practitioner or in a small firm and their relationships with clients on house projects may provide insights into the processes and relationships which impact on a significantly large portion of the profession.

2. CHARTING THE CLIENT-DESIGNER RELATIONSHIP DISCOURSE

Over the years, considerable work has examined relationships between clients and architects (Cuff, 1991; Cowdroy, 1992), clients and project managers (Zeisel, 1984; Kamara et al, 2002), clients and design managers (Sebastian, 2007; Emmitt, 2007) and project managers and design teams (Barrett & Stanley, 1999; Emmitt & Gorse, 2007). The boundaries between architects and clients have been blurred where an architect (acting as project manager, design manager, etc) may take on multiple roles on a project. For example, a project manager may represent both the 'client' and 'designer' groups on any one project. However, an underlying factor common to all projects is the need for these two major parties, that is, the design and client groups to work together to resolve conflicting project requirements. Therefore, rather than being limited to the study of *architectural management*, that is, the relationship between architects and clients, the review was widened to include material surrounding the broader discourse on *design management*. The review drew from key works in a range of fields and disciplines including architecture, management, psychology and sociology, which can be broadly categorised into four key themes including; design theory and methodology, environmental design and planning, communication and sociology of architectural practice (refer to Figure 1). Figure 1 charts some of the key trends and developments within the client-designer relationship discourse against the four themes between 1960 and 2008. The **bolded** texts represent key works and events specifically related to the study of architectural management whereas regular texts represent works and events related to the broader discourse on design management. The circled portion of the diagram represents the theoretical origins of the proposed approach to the management of the architect-client relationship. A detailed discussion of the review has been provided elsewhere (Chen, 2008), however, a brief overview is now presented.

Research relating to the first three themes has tended to focus on the development of prescriptive models suggesting a particular ideal methodology (for eg, Habermas, 1990; Yu et al, 2006). A variety of design process models (RIBA, 1973; Austin et al, 2000), briefing guides and tools (Kamara et al, 1999; Yu et al, 2006) and practice management guides and checklists (Sharp, 1981) have been developed over the past four decades within these three major themes. Although seemingly different in approach these three themes assume that the client-designer relationship can be systematically controlled and structured to achieve optimisation of briefing, design and construction activities to improve project performance. The emphasis has been on the "know-how", thereby resulting in a lack of deep understanding of the nature and underlying characteristics of relationships. Although useful for providing some order and logic to the overall design process, these tools or guides based on the prescriptive approach do not adequately capture the complexity of the design process. The nature of the design process has been described as "a leap into the unknown" (Friedl et al, 2002), necessitating architects to operate within a highly unpredictable process with unexpected jumps in phases and levels. Coupled with this is the need for architects to work with clients who may not understand and experience the unexpected jumps in phases and levels the same way they do given the differences in backgrounds and experience (Boyd and Chinyio, 2006). There is limited evidence to support the assumption that the prescriptive design approach suggested accurately reflects actual practice (Lawson et al, 2003; Aken, 2005). More importantly, most of these prescriptive models neglect the softer social aspects concerned with the promotion of effective collaboration (Friedl et al, 2002; Macmillan et al, 2002) resulting in a lack of understanding of the social complexity of the design process. Therefore, it is contended that the answer may not be in the development of another prescriptive model of the client-designer relationship.

An increasing number of empirical studies within the third theme of communication have provided critical insights into specific behavioural attributes of participants and how this influences project success (for eg, Barrett & Stanley, 1999; Emmitt & Gorse, 2007). In particular, understanding client behaviour and its impact on project delivery is an emerging area of interest (Bertelsen & Emmitt, 2005; Tzortzoulos et al, 2006; Boyd & Chinyio, 2006). Past studies have demonstrated that clients are confronted with uncertainties and require adequate support to help them understand and perform their activities on projects (Barrett & Stanley, 1999; Tzortzoulos, 2006). The client's ability to carry out their role effectively on projects has been established as critical to project success yet little information is available on client behaviour in terms of how they experience and overcome uncertainty on projects. Therefore what is key to future research is to explore how clients behave in their experience of uncertainty and how they effectively deal with unknowns in practice.

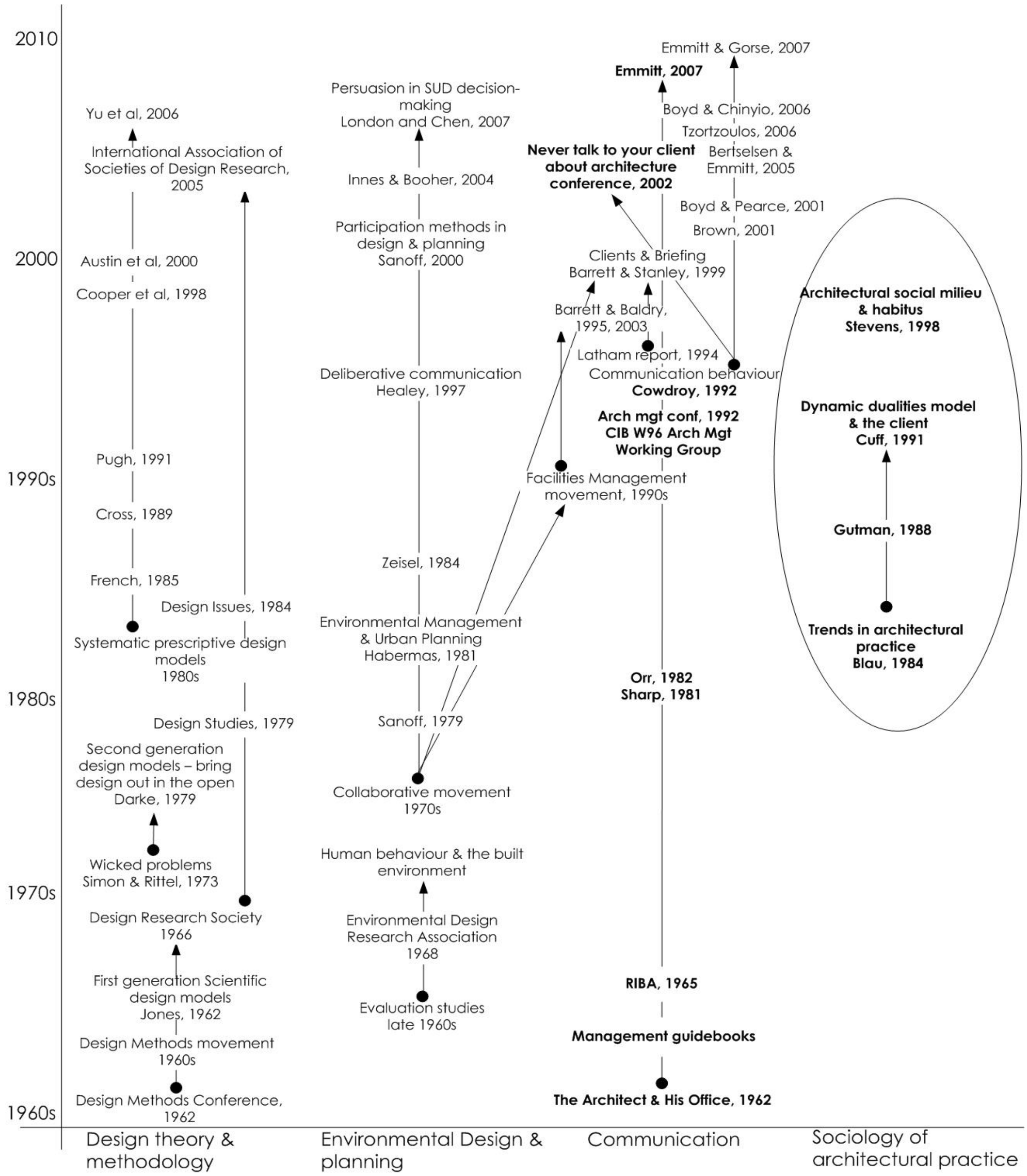

Figure 1: *Charting the client-designer relationship discourse*

Studies within the fourth theme (for eg. Cuff, 1991; Stevens, 1998) have revealed other subtle processes operating within the architectural milieu which present interesting tensions between architects and clients. A common thread linking the sociological studies of architectural practice is an identification of a social milieu underpinning the inner workings of architectural practice, which shapes their relationship with clients. In charting the typical life career of an architect, Cuff (1991) identified that each architect undergoes the "metamorphosis from layperson to architect within a frame created by the surrounding social milieu of practice" (Cuff, 1991, p.155). There is thus a tacit agreement of acceptable behaviour, reliable expectations and values that architects are expected to share. It is the maintenance of this social milieu by claiming a particular knowledge territory as distinctly their own and by keeping a degree of mystery about the knowledge base which allows the profession to establish a degree of autonomy from those clients they serve (Freidson, 1986; Stevens, 1998). The studies indicate the importance of considering the architect-client relationship within the sociological context of the design environment where architects and clients customarily play out their engagements (Blau, 1984). A key criticism of much design management literature is the tendency to neglect these very complexities that characterise the everyday practice of an architect (Cuff, 1991). To disconnect the study of architectural practice from their social milieu and its associated complexities is to inappropriately ignore the important underlying systems that architects are embedded in their dealings with the client (Stevens, 1998).

In summary, the review identified many prescriptive models suggesting a particular rational methodology to those seeking guidance to address design management problems. The majority of past work has either proposed multidisciplinary models for the management of client-designer relationships or has sought out appropriate disciplinary knowledge (for eg, management, sociology or psychology) to understand this built environment problem. Significantly there have been limited studies on the architect-client relationship based on a sociological approach even though the practice of architecture and the management of client-architect relationships is generally accepted as a social process (Luck & Haenlein, 2002). The review also highlighted a lack of understanding of how clients effectively deal with uncertainty in practice to achieve successful project outcomes. To explore this problem further, the concept of *habitus* is considered, which is a sociological construct particularly useful for explaining the behaviour in situations where the prevailing set of values and rituals governing practice such as the architectural practice are not explicit (Bourdieu, 1977).

3. CONCEPTUAL MODEL

The practice of architecture is one characterised by contradictory forces that present dilemmas to architects (Blau, 1984). In particular, the tension between design viewed as an art form and the implication that architecture is a business enterprise is a "dialectical duality" which architects have to contend with in their daily practice (Cuff, 1991). For many architects, the emphasis placed on pleasing clients to maintain a steady flow of jobs and to achieve profitability is seen as an act of compromise. For these architects, the business side of practice appears to take precedence, guiding the definition of the field, which goes against the underlying values and culture of the architectural social milieu (Gutman, 1988). Habitus theory contributes to a way of understanding the underlying values and culture of the architectural social milieu, which influences the relationships that architects have with clients.

3.1 Habitus theory

Bourdieu (1977, p.72) defines habitus as:

> "systems of durable, transposable dispositions, structured structures predisposed to function as structuring structures…which can be objectively 'regulated' and 'regular' without in any way being the product of obedience to rules, objectively adapted to their goals without presupposing a conscious aiming at ends or an express mastery of the operations necessary to attain them and, being all this, collectively orchestrated without being the product of the orchestrating action of a conductor"

Group habitus is the assembly of collective individuals encompassing group adaptations and acclimatisation, "'naturally' adjusted to the historical world they are up against" (Bourdieu, 1990, p.90). This enables an individual's involvement, familiarity or sense of being at 'home' within a social milieu, manifested through deep structural dispositions of acceptable perceptions, outlooks and ways or rules of conduct. Individuals within a group habitus experience the world on a common sense level, justified through their exclusive understanding of the world.

Habitus, 'systems of durable, transposable dispositions' entails that the nature of architecture as a specialised activity places architects within an *architectural habitus* comprised of unique dispositions, possessing specialist knowledge, skills and education, socially acquired through experience and practice and is continually reproduced over generations (Bourdieu, 1977; Stevens, 1998). The *architectural habitus* is comprised of cultivated individuals claiming a particular architectural knowledge territory as distinctly their own in order to establish a degree of autonomy from other members of the society. Cuff (1991) charted the metamorphic transformation of a layperson into an architect through a sequence of four distinct periods including as an architectural student, an entry-level architect, a project architect or associate and a principal. The four developmental phases tend not to be described explicitly to those undergoing the metamorphosis. Rather the layperson progressively 'learns the ropes' of the mysterious underpinnings of the profession over the course of becoming a full-fledged architect. Over time, architects become increasingly inculcated towards the mysteries of design practice and gradually "see the world in a new way", recognise the significance of peer review and develop segregation from the general public as they cross each invisible professional boundary. It is this process of socialisation that an architect commonly undergoes which distinctly sets members of the architectural habitus apart from other non-members (Chen, 2008). Group habitus is an important concept to consider because it helps to explain how the architect who is a member of the architectural habitus may differ from the client who is located within a different group habitus. The fact that the architectural field is not known to the client and vice versa is not without significance.

Specifically, the maintenance of the exclusive nature of the profession to continually reproduce "cultivated individuals" and "instruments of taste" requires a delicate balance since too much autonomy can eliminate the architect's position within the market and foster resentment against the profession (Cuff, 1991). As the findings of the RIBA studies (1992, 1993, 1995) alongside several other academic publications (Stater, 2002, Grilo et al, 2007) have consistently identified, the profession's tendency to be peer-oriented rather than client-oriented has had the unintended consequence of alienating clients where architects have been described as "arrogant" and "inflexible". The manner in which architects successfully strike a balance of autonomy in their relationship with clients is a central skill required of architects but is one that has received limited attention within the design management literature.

3.1.1 Habitus shock

Whilst the habitus is not explicitly tied to a theory of change, the dialectical confrontation of the habitus or what Bourdieu (2002) asserts, as a kind of '*second birth'* is a condition that has received the attention of various researchers (Friedmann, 2002; Hillier, 2002). *Second birth* refers to conditions where the habitus undergoes transformations as a result of fundamental environmental changes and/or educational learning. Within the contemporary social world context it is commonplace for individuals to encounter multiple second birth experiences as they transit from field to field over the course of their lives. Friedmann (2002) highlighted five ways in which the habitus theory can be extended beyond its primary task of explaining social reproduction to elucidate processes of change through second birth including escaping, forcing, challenging, accelerated change and breakdown of the habitus. These five changing conditions highlight the permeability of the habitus where both individual and group habitus can be fundamentally altered causing major transformations to social lives.

The concept of second birth is relevant to this research as it is concerned with the social space occupied by the architect and client during a project. It is proposed that a dialectical confrontation or mismatch between the architect and client's habituses takes place as they embark on a project together. The client's habitus may be inappropriate to cope with the unfamiliar architectural habitus, thereby resulting in potential discomfort. Generally when clients enter into relationships with architects they are uncertain about what is expected of them or what they can expect from the architect. A client's habitus may be in a state of shock when confronted with the architect who is of a different corresponding habitus and may undergo some form of adjustment similar to individuals experiencing *culture shock* who are undergoing radical change from one culture to another culture. For the purposes of this research, the mismatch between the architect and client's habituses, which presents a number of similarities with the culture shock phenomenon is termed *habitus shock* and is defined as the confusion or frustration experienced by clients who find themselves exposed to an unfamiliar architectural habitus and design process. To further explore the client's habitus shock experience, culture shock theory is considered as it has received considerable attention within the academic literature in psychology, for its contribution into understanding how the client adjusts to the unfamiliar environment during habitus shock.

3.2 Culture shock theory

The culture shock concept was first introduced in 1960 by Oberg to describe sojourners' intense disorientation, confusion and anxiety resulting from the loss of familiar cues in a new culture. More recently, the culture shock concept has been recognised to apply to any new situation requiring individuals to adjust to an unfamiliar social system where previous learning no longer applies (Griffiths et al, 2005). Individuals undergoing any radical change in their lives including a client experiencing habitus shock may undergo some form of adaptation parallel to conditions described by culture shock (Pedersen, 1995). Culture shock theory suggests a common stage-developmental process that sojourners undergo during culture shock and it is the developmental process the client undergoes and the consequences of the client's experience that need to be encapsulated within the context of this research.

3.2.1 Stage developmental process

From as early as 1955 (Lysgaard, 1955), there have been many attempts to describe the dynamic nature of the sojourner adjustment process. A common view is that the adjustment process is a stage-based developmental process (Pedersen, 1995), which is commonly referred to as the *U-curve* and is one of the best known process-centred models to describe the culture shock phenomenon (Black & Mendenhall, 1991). The *U-curve* views the adjustment process as one which moves from an initial optimism, elation and excitement through a subsequent dip as the sojourner struggles to fit in to the new culture toward a gradual recovery to a higher and more adequate level of coping and functioning in the new culture (Church, 1982; Shupe, 2007). Over the years the U-curve hypothesis has received varying degrees of support (Chen, 2008). Therefore it is important to describe the process in a balanced perspective when using the U-curve to explore the client's habitus shock experience.

Adler's (1975) five-stage developmental process identifies the potential for both positive and negative consequences that result from culture shock and is perhaps one of the few which views culture shock in a neutral rather than either negative or positive manner. For this reason, Adler's model was adopted for this study of the client's habitus shock experience. The five stages include (Adler, 1975; Black & Mendenhall, 1991; Pedersen, 1995):

- Honeymoon: a stage of discovery where curiosity, fascination and interest guide the sojourner's behaviour to experience new culture as exciting, interesting or even dreamlike. Individuals are often encapsulated by their own identity and tend to ignore problems encountered.
- Disintegration: a stage where the differences between cultures become evident and lead to confusion, isolation and loneliness. This is when the sojourner must realistically cope with living in the new culture on a daily basis. It is the stage where new cultural cues can be misinterpreted and may lead to frustration, disillusionment, depression and loneliness.
- Reintegration: a stage where the new cues are re-integrated and the sojourner develops an increased ability to function in the new culture. This stage is characterised by the sojourner's gradual adjustment to the new culture in learning appropriate host culture behaviour and norms. Although more capable to function in the new environment, one still holds feelings of resentment and hostility towards the host culture.
- Autonomy: the continued process of reintegration where one is able to view the differences between cultures in an objective and balanced manner. At this stage the sojourner develops a new sensitivity and understanding about the host culture and is able to function more competently within the new culture.
- Interdependence: the stage where one accepts and enjoys the differences between cultures and is able to function in both the "old" and "new" culture.

3.2.2 Habitus shock & learning

Various researchers have used the growth model to describe the positive consequences of culture shock where it tends to be viewed as a specialised form of learning or educational growth experienced by the sojourner (Pedersen, 1995). There has not been any clear definition of what constitutes learning; however, three key themes can be identified to indicate that the sojourner's experience of culture shock has resulted in learning:

- acquisition of skills and knowledge in relation to appropriate behaviour in the new setting to enable better adjustment (Kealey, 1988; Furnham & Bochner, 1986)
- greater self-awareness and broader and more complex worldview or perspective of host culture (Adler, 1975; Church, 1982; Brislin et al, 1986)
- greater enjoyment in the new environment (Brislin et al, 1986)

Perhaps an underlying theme across these indicators is their contributing role in leading to the sojourner's increased competency to function in the new environment. Sojourner learning is therefore demonstrated in their increased ability to deal with an unfamiliar environment with less difficulty and stress. This is quite easily translatable to the habitus shock phenomenon and the client's learning. When the client embarks on a house project a period of learning about the nature of the design process and its associated norms is necessary before the client is able to function competently in the new environment. Therefore the more adjusted the client is to the new environment the less difficulty is experienced.

It is suggested that there are two key factors which can facilitate the client's learning during habitus shock, namely the development of coping strategies by clients and the compatibility between the architect and client's habituses. Firstly the client can have an active role in developing strategies to help them cope with the unfamiliar environment. The client who is confronted with an unfamiliar design and construction process can become disoriented in the new environment. Everyday design issues which may seem simple to the architect can be perceived as confusing or even overwhelming by clients who are not typically exposed to such issues. It is at this uncertain stage that misunderstandings between the architect and client can occur and therefore a degree of learning about the other party's habitus is essential to reduce uncertainties and avoid misunderstandings. Throughout the design and construction processes, the architect may utilise various methods to clarify issues with the client to reduce uncertainty in progressing the project. At the same time, the client may seek to acquire new skills and knowledge in relation to the design process to help them function with increased competency within the new environment. Therefore paying attention to how the client behaves and perhaps develops coping strategies may help to refine the understanding of the client's behaviour in relation to the habitus shock phenomenon.

Secondly, consistent with the "cultural fit" concept within the culture shock phenomenon, the level of compatibility between the architect and client's habituses may impact on the client's learning. The "cultural fit" concept is based on the premise that the transfer of home culture learning relies on the similarities or differences between the home and host cultures (Bochner, 1972). The greater the difference between the home and host cultures, that is, "cultural distance", the more difficulties the sojourner experiences in their adjustment process (Furnham & Bochner, 1982; Triandis et al, 1994). During the client's encounter with habitus shock, both the architect and client may continuously seek ways to achieve increased "fit" between the habituses to assist the client's adjustment process for the project to progress. In most cases, clients ultimately hold the final control over major decisions to be made on house projects. Therefore project progress can be largely reliant on the client's ability to make decisions within appropriate timeframes. Making decisions concerning issues relatively unfamiliar to the client can, however, be particularly challenging. This is when learning about the complexities of the design process and the architect's language is crucial in assisting the client's ability to contribute to decision-making throughout the design process. A lack of shared language between the architect and client can impact on the client's learning process since the architect has a key role in explaining and familiarising the client with the complexities surrounding the design process. Therefore it is argued that an increased level of compatibility between the architect and client's habituses can facilitate the client's learning.

4. HABITUS SHOCK MODEL FOR SUCCESSFUL ARCHITECT-CLIENT RELATIONSHIPS

Figure 2 is an abstract representation of the social space occupied by the architect and client over the course of their relationship on the house project. An underlying assumption is that the architect and client's habituses have a degree of influence over each other during habitus shock. It proposed that the effective management of the client's habitus shock experience can improve or hinder the success of the architect-client relationship.

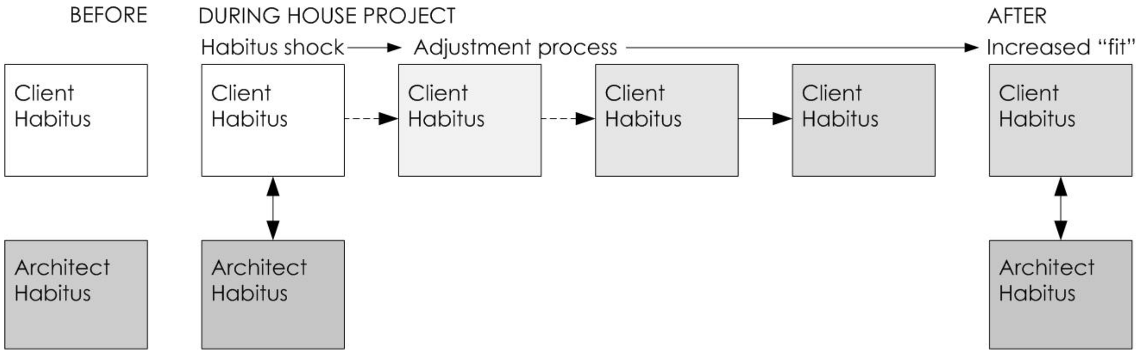

Figure 2: *A model for successful architect-client relationships on house projects*

It is suggested that the client's adjustment experience on the house project can result in learning which in turn leads to an increased fit between the architect and client's habituses. The closer the fit between the habituses the less likely it is for conflicts to occur and hence the higher the likelihood for the quality of the architect-client relationship to be enhanced. Therefore it is proposed that client learning during habitus shock is a characteristic of successful architect-client relationships, which can be demonstrated in the client's increased adjustment and ability to function competently in the new environment. There is currently little detailed knowledge of how the habitus undergoes transformations in such situations. Understanding the client's habitus shock experience and the extent to which the habitus can change is significant since it influences the client's experience of a project which shapes their perceptions of the overall success of the architect-client relationship. The client's habitus shock experience, when managed appropriately offers the potential to enhance their experience and thereby ultimate satisfaction and this is worthy of further studies.

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Client management on house projects: facilitating client learning for successful architect-client relationships

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ABSTRACT

This paper reports the findings of a study which examined architect-client relationships on house projects with a focus on the supportive role of architects in helping clients deal with project issues. *Habitus* theory explains that the nature of architecture as a specialised activity places architects within an *architectural habitus,* distinguishing them from clients who are not trained in the field, which is at the heart of the problematic architect-client relationship. An underlying premise was that *habitus shock*, that is, a mismatch between the architect and client's habituses occurs as they enter into a relationship on the house project. Using the qualitative approach underpinned by the constructivist perspective for data collection and analysis, eight in-depth interviews were conducted across five case studies of successful architect-client relationships. The narrative inquiry approach was used to establish the extent to which habitus shock occurred and to describe the stages involved in the client's adjustment process during habitus shock. The findings indicate that habitus shock occurred on all five case studies, which resulted in client learning, enabling clients to function with competency in the unfamiliar environment. Client learning achieved during habitus shock was directly linked to the amount of difficulty experienced. This study has refined our understanding of the architect-client relationship on house projects by exploring more deeply client behaviour and the ways in which clients successfully deal with difficulties on house projects rather than simply identifying the uncertainties and conflicts that occur on projects. The findings demonstrate that client learning during habitus shock is a characteristic of successful relationships. One of the most significant outcomes of this study is that it demonstrated the potential to facilitate client learning during habitus shock to contribute to the development of successful architect-client relationships.

KEYWORDS

Client management, client behaviour, architect-client relationships, narratives, case studies

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1. INTRODUCTION

Since the 1960s, a number of government and industry reports have consistently drawn attention to the low level of client satisfaction with the construction industry as a whole (Gyles, 1992; Latham, 1994; Egan, 1998) as well as specifically the architectural profession (RIBA, 1991; 1992; 1995) arising from the lack of integration in project teams. During the intervening years, the industry has adopted concepts such as partnering, supply chain management and innovative procurement strategies based on an expectation that such initiatives would lead to improved relationships and project performance. Considerable attention in recent years has also been paid to the development of information technologies and information communication technologies to improve project communication. Despite these efforts, evidence shows that dispute occurrence arising from adversarial project relationships is still a major problem facing the construction industry (Gebken et al, 2006), accounting for approximately 40% of all industrial disputes in Australia (Andrews, 2004).

A common approach undertaken by researchers has been to develop prescriptive models suggesting a particular ideal methodology (for example, Cooper et al, 1998; Austin et al, 2000). These models assume that relationships can be systematically controlled and structured to achieve optimisation of design and construction activities to improve project performance. The emphasis has been on the “know-how”, thereby resulting in a lack of deep understanding of the nature and underlying characteristics of relationships (Emmitt and Gorse, 2007). Briefing and design guides, tools and checklists developed over the years seem to have had limited impact in practice (Kamara et al, 2002; Yu et al, 2005), yet the focus of recent research has remained on the development of more prescriptive models.

An increasing number of empirical studies conducted to explain the nature of relationships have provided critical insights into specific behavioural attributes of project participants and how this influences the success of relationships. A range of relationship-types have been explored including architect-client (Cuff, 1991; Cowdroy, 1992), project manager-client (Barrett and Stanley, 1999), project manager-design team (Emmitt and Gorse, 2007) relationships. In particular, understanding client behaviour and its impact on project delivery is an emerging area of interest (Bertelsen and Emmitt, 2005; Boyd and Chinyio, 2006). Past studies on client behaviour indicate the significance of identifying effective ways in which clients experience and overcome difficulties in practice in order to achieve healthy relationships and successful project outcomes.

This paper reports the findings of a study, which was concerned with examining architect-client relationships on house projects with a focus on the supportive role of architects in helping clients deal with project issues. Drawing from sociological and psychological theory, the study examined five successful architect-client relationships, revealing ways in which clients effectively dealt with uncertainties on projects. The study identified that successful architect-client relationships were characterised by client learning and that over the course of the relationships, architects supported clients to learn new skills, helping them overcome difficulties faced on projects. This study has refined our understanding of the architect-client relationship by exploring more deeply client behaviour. In particular it provides detailed descriptions of the way in which clients successfully deal with difficulties rather than simply identifying the conflicts that occur on projects. One of the study’s most significant outcomes is that it demonstrated the potential to facilitate client learning during habitus shock to contribute to successful management of architect-client relationships.

2. HABITUS SHOCK MODEL FOR ARCHITECT-CLIENT RELATIONSHIPS ON HOUSE PROJECTS

Habitus theory borrowed from sociology entails that the nature of architecture as a specialised activity places architects within an *architectural habitus* comprised of unique dispositions, possessing specialist knowledge, skills and education, socially acquired through experience and practice and is continually reproduced over generations (Bourdieu, 1977; Stevens, 1998). The *architectural habitus* is comprised of cultivated individuals claiming a particular architectural knowledge territory as distinctly their own in order to establish a degree of autonomy from other members of the society. The concept of group habitus helps to explain how the architect who is a member of the architectural habitus may differ from the client who is located within a different group habitus. The fact that the architectural field is not known to the client and vice versa is not without significance.

A general implication within habitus theory is that the habitus is fairly stable in that the habitus reproduces continuous generations of lifestyles (Bourdieu, 1977). However, more recently literature suggests that the habitus is more malleable than what was previously accepted (Friedmann, 2002; Waterson, 2002). *Second birth* refers to conditions where the habitus undergoes transformations as a result of fundamental environmental changes and/or educational learning. Similar to the second birth experience, it is proposed that a mismatch between the architect and client's habituses takes place as they enter into a relationship on the house project where the client's habitus may encounter conditions different from those in which they are accustomed to. The client's habitus may be inappropriate to cope with the unfamiliar architectural habitus, thereby resulting in potential discomfort. Generally when clients enter into relationships with architects they are uncertain about what is expected of them or what they can expect from the architect. A client's habitus may be in a state of shock when confronted with the architect who is of a different corresponding habitus and may undergo some form of adjustment similar to individuals experiencing *culture shock* who are undergoing radical change from one culture to another.

The term *habitus shock* is introduced in this study and is defined as the confusion, stress or frustration experienced by clients who find themselves exposed to an unfamiliar architectural habitus and design and construction process as a result of a mismatch between the architect and client's habituses. Figure 1 is an abstract representation of the social space occupied by the architect and client over the course of their relationship on the house project. An underlying assumption is that the architect and client's habituses have a degree of influence over each other during habitus shock. It proposed that the effective management of the client's habitus shock experience can improve the success of the architect-client relationship.

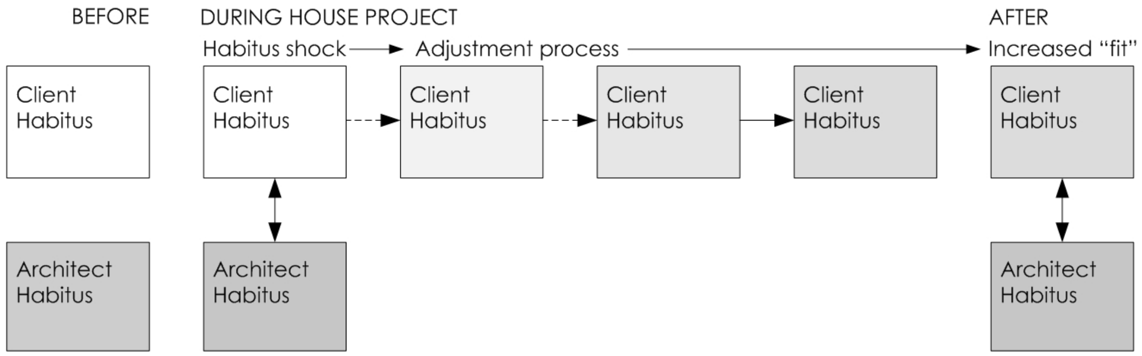

Figure 1: *A model for successful architect-client relationships on house projects*

It is suggested that the client's adjustment experience on the house project can result in learning which in turn leads to an increased fit between the architect and client's habituses. The closer the fit between the habituses the less likely it is for conflicts to occur and hence the higher the likelihood for the quality of the architect-client relationship to be enhanced. Therefore it is proposed that client learning during habitus shock is a characteristic of successful architect-client relationships, which can be demonstrated in the client's increased adjustment and ability to function competently in the new environment. This study sought to describe and explain the client's adjustment experience during habitus shock on house projects based on the proposed conceptual model (refer to Figure 1).

3. RESEARCH METHODOLOGY

Due to the exploratory and inductive nature of the model, the methodology was derived from the logic of qualitative research methodology and in particular the constructivist paradigm (Denzin & Lincoln, 2005). A key methodological issue considered was related to revealing the client's behaviour on projects and how this influenced the architect-client relationship. The narrative inquiry approach was considered appropriate for this study because it:

- takes into account the subjectivity of the narrators, that is, the architect and client and also the context within which the narrative is told
- is particularly useful for systematically studying the key events within the client's habitus shock experience and for connecting and seeing the consequences of those events and actions mapped against the five stages of the culture shock process
- provides the opportunity to intimately understand the "insiders view" of the architect-client relationship and in particular, the client's stories of their habitus shock experience.

The face-to-face, individual interview process was the main method for data collection. Eight in-depth interviews were conducted with two architects and their four clients across five case studies. Architects were asked questions in relation to:

- the type of work they conducted and the manner in which they conducted their work in general terms to provide some context to establish their architectural habitus,
- their relationships with clients in general to provide background to the type of clients they worked with and their general approach to managing relationships with clients,
- the specific case studies and the associated relationships they developed with the client for each case. As this study was aimed at examining successful architect-client relationships architects were asked to identify potential case studies which they perceived had achieved successful architect-client relationships.

The client interviews were guided by the architects' stories. The key aim of the client interviews was to allow clients to narrate stories which represented "critical moments" in their experiences on the house project. Clients were invited to tell stories relating to:

- the uncertainties or difficulties they encountered throughout the project
- any standout moments they remembered, whether positive or negative
- their interactions with the architect and how this impacted on their experiences

The story analysis technique was used for analysing the data as it offers a way of connecting different stories to understand a phenomenon and in particular changes that take place over time (Bell, 1993). The story analysis allowed for the examination of how the client achieved learning over time through habitus shock. The first phase of analysis involved the transcription of "rough drafts" of the entire interview to develop narrative segments. The narrative segments were interpreted to identify the meaning of each individual story. Based on the client's behaviour, feelings or actions described within the stories, each story was then classified into categories according to the primary characteristics of the five stages of culture shock. A common view is that the adjustment process is a stage-based developmental process (Pedersen, 1995), which is commonly referred to as the *U-curve* and is one of the best known process-centred models to describe the culture shock phenomenon (Black & Mendenhall, 1991). The *U-curve* views the adjustment process as one which moves from an initial optimism, elation and excitement through a subsequent dip as the sojourner struggles to fit in to the new culture toward a gradual recovery to a higher and more adequate level of coping and functioning in the new culture (Church, 1982; Shupe, 2007). Over the years the U-curve hypothesis has received varying degrees of support (Chen, 2008). Therefore it is important to describe the process in a balanced perspective when using the U-curve to explore the client's habitus shock experience. For this reason, Adler's (1975) five-stage developmental process model was adopted for this study of the client's habitus shock experience because it is one of the few culture shock models which identifies the potential for both positive and negative consequences that result from culture shock.

The next stage of analysis involved linking the different stories into chronological order. The stories coded into the five stages of culture shock were then "pasted together" to form a "metastory" to demonstrate the client's adjustment process during habitus shock (refer to Figure 3 in appendix 7.1 for an example of a metastory developed for this study).

4. RESULTS & DISCUSSION

Each case study was analysed as an independent unit and subjected to three stages of analysis. The findings reported in this paper are a result of the final stage of analysis, which included a comparative analysis between case studies to ascertain common themes and irregularities.

4.1 Background

Five architect-client relationships formed the five case studies explored in this study. Two practising architects in New South Wales, Australia were selected for this research. As shown in Figure 2, the five cases present a number of similarities and differences in the level of exposure the clients have had in relation to an architect and the associated architectural habitus. Clients 1, 3 and 5 were involved in one completed house project each. Therefore Clients 1, 3 and 5 have had the experiences of being in a relationship with Architects 1 and 2 respectively from the beginning till the end of a house project and have lived in the house after project completion. Client 4 on the other hand was involved with one completed house project and at the time of the interview was in the process of their second project and relationship with Architect 1. Clients 3 and 4 are the same people. However, for the purposes of this study given that the unit of analysis is the architect-client relationship, the two projects and associated relationships were analysed separately as individual units of analysis. The analysis of case study 4 was therefore limited to Client 4's relationship with Architect 1 until the end of the design stage, however, was informed by their past experiences of having been in a relationship with the architect on their previous project, that is, case study 3. At the time of the interview with Client 2 the project was in the process of progressing to the construction stage. Client 2 had only been in a relationship with Architect 1 from the start of the project until the beginning of the construction stage and therefore the discussion on case study 2 is limited to the analysis of the relationship within this time period (refer to Figure 2).

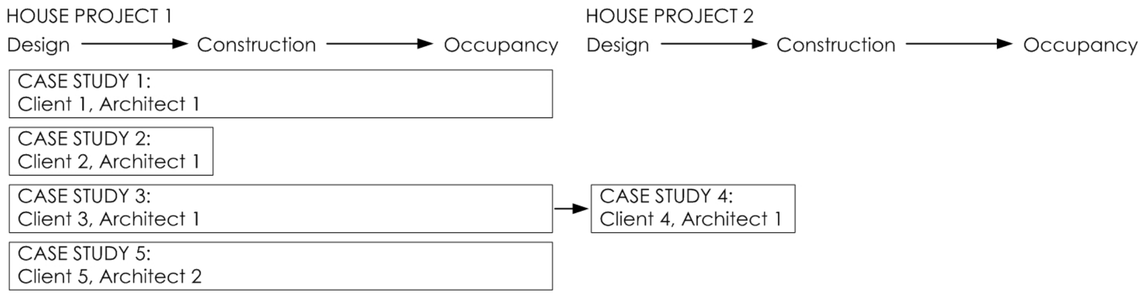

Figure 2: *The different characteristics of the five case studies*

4.2 Confirmation of project success and habitus shock occurrence

An important part of the client interviews was to confirm that the clients were satisfied with the project outcomes. All case study clients and architects achieved successful architect-client relationships. The architect and client from each case confirmed that they were satisfied with the project outcomes and the way in which the architect-client relationship developed.

The first stage of analysis established whether the clients experienced habitus shock on the projects. The analysis revealed how all five clients encountered habitus shock on the projects. Each client experienced a degree of disorientation at some stage of the design and/or construction process. The degree to which they experienced habitus shock differed across the case studies; however, the analysis demonstrated how they were confronted with a new environment as they entered into the architect-client relationship on the projects. The clients found themselves being immersed in a state of uncertainty with little real understanding of the nature of the design and/or construction process and the associated architectural habitus. Even client 4 who had previously been involved in an architect-client relationship on another house project was confronted with a number of unexpected issues on their second project. Client 4 was, however, better equipped to deal with the uncertainties on their second project and was able to enjoy the design process. This was attributed to the learning Client 4 achieved on the first project when they were exposed to the iterative nature of the design process.

4.3 Habitus shock profiles

From as early as 1955 (Lysgaard, 1955), there have been many attempts to describe the dynamic nature of the sojourner adjustment process when experiencing culture shock. A common view is that the adjustment process is a stage-based developmental process (Pedersen, 1995). This process, which is commonly referred to as the *U-curve* views the adjustment process as one which moves from an initial optimism, elation and excitement through a subsequent dip as the sojourner struggles to fit in to the new culture toward a gradual recovery to a higher and more adequate level of coping and functioning in the new culture (Church, 1982; Shupe, 2007). Within this idealised growth model, the sojourner acquires knowledge and skills, which allows them to adjust to the new environment to achieve a positive outlook of their experiences. The process of recovery towards the more positive elements of autonomy and interdependency may not always be achievable though and it is when this does not occur that the sojourner's adjustment experience results in negative consequences (Pedersen, 1992).

Within each case study, client stories were identified and coded into the five stages of culture shock (refer to Figure 4 in appendix 7.2). Four out of the five clients experienced all five stages of culture shock throughout their habitus shock experience including honeymoon, disintegration, reintegration, autonomy and interdependency. Client 4 only experienced three stages of the culture shock process, namely reintegration, autonomy and interdependency. The case studies demonstrated that uncertainties and the associated stresses are inevitable on projects and typically occur during the construction stage. However, when describing stories of disintegration, the clients not only explained the situations which led to their feelings of disorientation but also how they eventually escaped the stage. The clients demonstrated a relaxed attitude and had a positive outlook even when confronted with challenges on the project. Furthermore the clients' positive attitude was a result of a more long-term and meaningful understanding of the nature of the design and construction process and the associated architectural habitus. In particular, the client in case study 4 achieved the positive elements of reintegration and interdependency without progressing through the negative stages of honeymoon and disintegration, which was experienced on a previous project.

The five habitus shock profiles in this study showed that the adjustment experience of clients who achieved successful relationships resembles the growth model of culture shock, which results in learning. All clients progressed through the different culture shock stages and ultimately achieved a positive outlook of their habitus shock experience. Relatively few stories in the case studies illustrated aspects of honeymoon and disintegration stages and a significantly higher number of stories demonstrated aspects of the reintegration, autonomy and interdependency stages. The high number of stories found within the reintegration, autonomy and interdependency stages indicate that the clients' adjustment experiences were largely characterised by positive elements of recovery, enjoyment and increased awareness rather than the more negative elements of naivety, stress and discomfort associated with the honeymoon and disintegration stages.

4.4 Client learning & successful relationships

The findings indicated that all clients experienced a degree of disorientation as a result of being confronted with unfamiliar design and construction issues. This is supported by past studies exploring client behaviour where it has been established that clients experience difficulties on projects due to their lack of understanding of design and construction issues (Barrett and Stanley, 1999; Bertelsen and Emmitt, 2005; Tzortzoulos et al, 2006; Boyd and Chinyio, 2006). It has been demonstrated that the client's inability to cope with unfamiliar design and construction issues can hinder the successful delivery of project outcomes. This study has confirmed the difficulties associated with the clients' lack of understanding of design and construction issues and has also identified effective ways in which clients used to deal with uncertainties on house projects to achieve successful outcomes. Primarily the strategies undertaken by clients to cope with uncertainties revolved around the clients acquiring some form of learning to function more competently in the unfamiliar environment. The discomfort the clients experienced as a result of the uncertainties became less over time, indicating that the client's adjustment difficulties decreased over time. The habitus shock experience provided clients with opportunities to develop coping strategies over time, which reduced the level of stress experienced. Therefore, even though the clients were continually confronted with uncertainties, their newly acquired coping strategies helped them develop a sense of familiarity in the new environment to limit the amount of difficulty experienced.

The three key indicators of client learning included the client's acquisition of skills and knowledge in relation to the design and construction process, a more complex worldview of the architectural habitus and an ability to take greater enjoyment in the new environment. Client learning achieved during habitus shock can be directly linked to the amount of difficulty experienced. The more adjusted the client is to the new environment the lower the level of difficulty experienced and therefore the more positive the adjustment process. Therefore client learning during habitus shock is a characteristic of successful relationships.

4.5 Factors facilitating learning

The analysis demonstrated that there are factors which can facilitate client learning, which impacts on the quality of their adjustment experience and success of the architect-client relationship. In all cases examined, the compatibility between the architect and client's habituses and a high level of trust and reliance on the architect were identified as two key factors which led to clients' increased competency to function in the uncertain environment.

4.5.1 Compatibility between habituses

The analysis showed that the concept of cultural fit is relevant in explaining client learning during habitus shock. Specifically, it demonstrated that the compatibility between the architect and client's habituses contributed to client learning on the projects. This study has not only confirmed the significance of the compatibility between habituses in enhancing the client's adjustment process but has also revealed specific characteristics about the compatibility between habituses which resulted in successful relationships. Three key themes were identified across the cases to indicate the significance of the compatibility of habituses between the architect and client in facilitating client learning during habitus shock.

The first key theme across all cases was the clients' reliance on recommendations in selecting their architect. All clients indicated that they sought to develop an understanding of the architect prior to engaging them to work on the projects. All clients received positive feedback about the architect from friends, work colleagues or family members, indicating that the clients had a general idea of the relationship they were entering as well as the building outcome that would be achieved if they employed the architect. Seeking recommendations offered these clients a degree of assurance, that if people within their social milieu were satisfied with the architect then they would likely be satisfied also.

The second theme revolved around the architect and client holding similar values on how they perceived a professional relationship should function. Ultimately, the architect is engaged as a designer to transform the client's needs into reality. It has long been recognised that architectural design is the architect's key contribution to clients and architects are in an excellent position to apply knowledge on many of the complex design issues surrounding projects (RIBA, 1992, 1993). The architects perceived that as the professional in the relationship they were in the position to contribute to achieving their client's needs while improving the quality of the project and indicated that their clients appreciated the contributions they made on the projects. Findings from this study confirmed that the architects' designs were highly valued by all clients interviewed. The findings also demonstrated that even though the architect had the capacity to contribute to the design, there was still the need for clients to be willing to accept the architect's advice. In all cases examined, the architect was seen as the primary decision-maker on projects where the clients relied on the architect's advice on various project-related issues such as the development application process, detailed design and construction and project management. All the clients viewed the architect as the 'expert' and provided a high level of autonomy to the architect on. Both the acceptance of the relationship as a form of partnership as well as the client's high level of respect and trust for the architect's expertise contributed to the success of the relationships. The architects were only able to improve the quality of the projects because the clients provided them the opportunity to offer their professional opinion. It was only through this shared understanding and mutual respect for their specific roles in the relationship that enabled the clients to overcome many of the potentially stressful situations on the projects.

The third theme was the high level of compatibility between the architect and client in terms of personal chemistry. Both the architects explained their preference for working with clients who had an interest in the quality of their house and also those who were able to communicate this easily. For these architects, an intimate relationship with the client was key in enabling them achieve the quality and depth of understanding which resulted in appropriate design solutions. Often, the client may not accurately describe to the architect their requirements and therefore where there is a personal chemistry, the architect is better placed at observing and gathering information about the client's personality traits and preferences to develop appropriate design solutions. Similarly, the clients highlighted the significance of the chemistry or bond they had with the architect and how it contributed to their positive experiences on the project. It was through the intimacy and chemistry between the architect and client that the client was able to express themselves with ease and comfort.

4.5.2 Architect's role

The supportive role of the architect was identified as central in leading to the success of the architect-client relationships in all cases explored. A key coping strategy used by all clients was the development of a support system, which revolved around the architect's 'training' role to help them adjust to the new environment. The clients from all case studies demonstrated a high level of reliance and trust in the architect on all project issues, which provided the architect the freedom to develop creative solutions. The availability of the architect acting as a 'tutor' also placed the client in a better position to acquire increased competency to function in the new environment and in turn take enjoyment in the process.

The case studies demonstrated the significance of investing time in developing the architect-client relationship to enable clients to gain adequate trust in the architect's ability to function as a support system. The client stories demonstrated how each client developed increasing competency to function in the new environment where their sense of self-assurance was achieved over time. Different clients adjusted at their own rate and relied on a high level of communication with the architect. The architects also emphasised the significance of investing time and effort in ensuring that the clients felt comfortable and had a good understanding of the design and process. While it may not seem convenient to invest a high amount of time in developing relationships, the case studies demonstrated the benefits of achieving trust between the architect and client outweighed the initial investment of time. In all cases explored, the clients explained how they developed trust and respect for the architect and were of the belief that their needs and ideas were valued by the architect on both professional and personal levels. The clients trusted that the architect knew them and their family on a personal level and was able to propose design solutions based on a clear understanding of their requirements. The clients also placed considerable faith in the architect to manage the project in a professional manner and with the client's interests at heart.

There are two key reasons which may explain why mutual trust and respect were necessary for the success of the architect-client relationships. Firstly the development of trust for the architect was seen by the clients as central in their ability to develop a more relaxed attitude to enjoy their new environment and the uncertainties they experienced. Secondly, the client's trust in the architect enabled the architect's specialist opinion to be used to its full potential. Although the clients were actively involved in the design process they did not make decisions concerning design and construction issues. The clients from all case studies demonstrated a high level of co-dependency on the architect when making decisions on the project. The client's recognition of the architect's competencies was crucial in giving the architect the freedom required to develop creative solutions. This allowed the clients to acquire increased competency to function in the new environment and in turn take enjoyment in the process.

5. CONCLUSION

The analysis highlighted that habitus shock occurred on all case studies in some form which was represented by clients undergoing a period of adjustment similar to a sojourner experiencing the different culture shock stages. The sequence in which the clients encountered the different stages was, however, not as easily recognisable as the idealised U-curve model. Despite the different habitus shock profiles, all clients progressed through the different culture shock stages to ultimately achieve a positive outlook of their habitus shock experience. The clients who all achieved successful architect-client relationships experienced positive adjustment processes and demonstrated relaxed attitudes even when confronted with challenges on the project. The clients' ability to develop a positive outlook of their habitus shock experiences led to the successful delivery of project outcomes. Client learning achieved during habitus shock can therefore be directly linked to the amount of difficulty experienced and is a characteristic of successful relationships.

One of the most significant outcomes of this study is that it demonstrated that there are factors which can facilitate client learning during habitus shock and that architects play a key role in facilitating client learning. Therefore there are ways in which clients can be provided support to help them deal with uncertainties on projects to achieve successful outcomes. Although the habitus shock experience and the associated uncertainty and discomfort is difficult to prevent, it is possible to prepare clients for the experience. This study simply begins the development of a more detailed understanding of the role that architects can play in providing adequate support to clients. It is perhaps fruitful to ask what can the architect learn about their skills and capacity towards client management? What do we already know about improving the management of architect-client relationships and what role can the architect play? It is suggested that more research on the architect's role in facilitating client learning could provide critical insight into the supportive role required of architects during habitus shock.

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7. APPENDICE

7.1 Example of a metastory developed on the study: case study 5

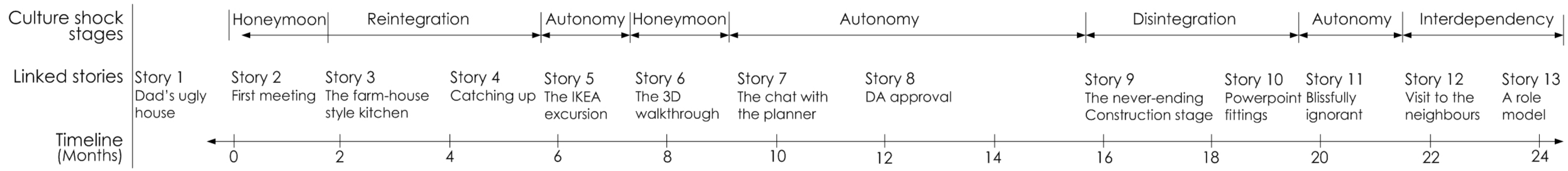

Figure 3:. *Client 5's adjustment process during habitus shock*

The stories cover a period of approximately 24 months from project initiation until project completion. In summary the stories were about C5 developing skills and knowledge to enjoy the new environment she was in. In the first story, C5 explained how she was convinced by her brother-in-law that she needed an architect when he reminded her of her "dad's ugly house" which was built without the use of an architect. The second story shows how, after being somewhat unsure about the potential value of employing an architect, C5 was impressed by A2's expertise and involvement with the university and building advisory body and excited that they had "clicked" at their first meeting. The following two stories highlight how C5 was gradually introduced to the iterative nature of the design process and how she started to develop increased understanding of A2's unique contributions. In Story 5, C5 highlighted how A2 helped her overcome the potentially stressful task of designing kitchen fit-outs by teaching her "how to use IKEA" and they had "the most wonderful time". In the sixth story, C5 remembered being "blown away" the first time she was shown the complete version of the 3D CAD model of the proposed design. The seventh and eight stories indicate C5's continued development of a broader worldview of the complexities that can occur on projects and her increasing appreciation for the role of A2 in not only ensuring the successful completion of her house project but also in enabling her to to enjoy the unfamiliar environment. Stories 9 and 10 demonstrate C5's increasing sense of impatience for the project to finish, as she felt tired and overwhelmed by the need to make decisions on unfamiliar issues such as "powerpoint fittings". In Story 11 she explained how she overcame many of the potentially stressful situations during the construction stage by simply passing over the decisions to A2 indicating the level of trust she had for A2 at that stage. The final two stories demonstrate C5's refined understanding of the value and the unique contributions of A2 in providing her the "individualised" and "beautiful" house she was clearly pleased with.

7.2 Habitus shock profiles of the five case study clients

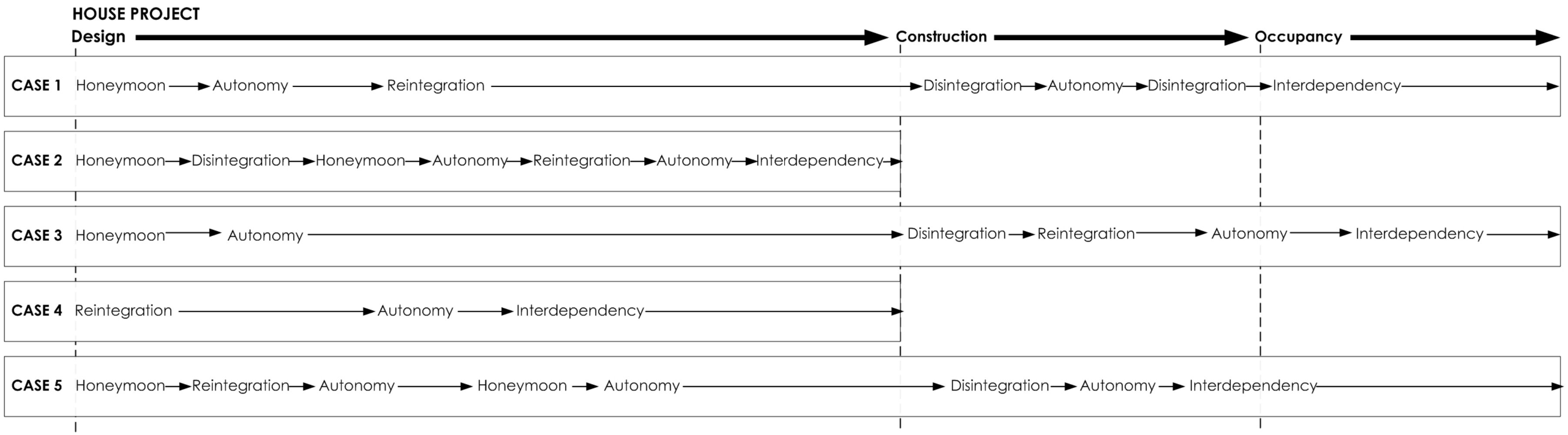

Figure 4: *Habitus shock profiles of the five case study clients*

In summary, two key observations can be made based on the characteristics of the five habitus shock profiles including:

- the clients' frequent experience of the positive elements of reintegration, autonomy and interdependency and their limited encounter with the negative honeymoon and disintegration stages, resembling the growth model of culture shock, and
- the client's decreasing adjustment difficulties over the course of the project.

Mega-Challenges: Programming Management for Event Projects

Ying DENG[1]
SW POON[2]

ABSTRACT

While the pursuit of signature event architecture never slows down, solutions to the post-utilization issues seem too slow to catch up, leaving behind many "white-elephant"-type event legacies. Despite such mega-failures originated from a dearth of long-term visions beyond the events on the organizer side, academic interest in the domain of programming event projects has long trailed its significance, resulting in an absence of a readily accessible pool of literature and experience both within and outside China.

As a preview to an ongoing case study on the Big4 public building projects of Expo 2010 Shanghai China, this paper first attempts to outline the general programming challenges of balancing temporariness and permanency implicit in such event architecture. In-depth explanations will then be given as to why the research pivots on how to manage the processes of programming the centerpieces of event-catalyzed urban renewal practices - high-profile public building projects from the client. Finally, a brief overview of the specific programming challenges of the Big4 will be provided based on the author's four years of work experience as a client member and project coordinator with the Expo Organizer during the project initiation stage.

KEYWORDS

challenge, programming management, event project, client organization, the Big4 of Expo 2010

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1. PROLOGUE

Expo 2010 Shanghai China has been often put on a par with Beijing 2008 Olympic Games as the two highly anticipated mega-events for a rising China in the new millennium. Increasing global clout of the Chinese economy endows the twin with a much more significant role beyond the aura of event. With Beijing Olympics lowering its curtain, all eyes set on the upcoming Shanghai Expo in anticipation of another best-of-all-time "Economic Olympics". For the Expo Organizer, however, it is enlightening to review the gentle reminder by Dennis Pieprz, President of Sasaki - the winner of Beijing Olympic Green International design competition, "you are making a city, not a spatial extravaganza that will be interesting for 16 days".

2. MEGA-PROBLEMS, MEGA-CHALLENGES

As long as the terms programming (briefing) and event run parallel, a question concerning their products - the program and the event project, is how to view them: as a beginning of an end in themselves, or as an end of a beginning towards a more sustained process? The reason for this enquiry is embedded in their long-term chronics.

2.1 Mega-Problems

Globally, urban renewal has become a catchword in search of an antidote against the fragmented city images inherited from the previous era of industrialization. This helps explain why there exists such an intimacy between ambitious cities and large-scale renewal projects that are not only ranked among the top policy agendas but also positioned in the prominent locations. In this connection, mega-events, such as the FIFA World Cup, the Olympic Games and the World Expos, have become a desired catalyst in stimulating such renewal programs. These influential events did produce many architectural masterpieces as the most visible legacies and effective branding tool for establishing or re-shaping city identities. However, an examination of the previous legacies shows a wide spectrum between successful transformation and miserable degeneracy among host cities (Usborne, 2008). While the pursuit of signature architecture in the name of mega-events has never slowed down until the outbreak out the global economic tsunami in 2008, solutions to the post-utilization issues seem too slow to catch up, leaving behind many purpose-built event buildings as white elephants. With a global surge of megaprojects since the 1990s, the affiliated mega-failures are never uncommon (Flyvbjerg et al., 2003). The post-event performance records of these physical giants are often notoriously poor representative of huge cost overruns and sharp benefit shortfalls. This phenomenon again validates Seeley's (1983) notion that the larger the financial input, the lower rate of fulfilling the client requirements.

A case in point is Sydney 2000 Olympics. The two purpose-built stadiums, once applauded as cutting-edge sporting venues (Allen et al., 2005), have already suffered from a major revenue declines resulting from a lack of steady flow of major events after year 2000 and the regional competition from existing venues (Searle, 2002). The redevelopment of the Sydney Olympic Park also fell short of expectation for lack of a legacy program for the site, as admitted by the Games' former chief planner (Usborne, 2008). While the list of poor-performers can go for a global tour, the Achilles Heel lies in the absence of long-term planning and programming considerations at the initiation stage. In fact, event projects are not the only victim. Despite a deepening awareness of its significance among practitioners and a tremendously enriched pool of literature by researchers, programming itself has been a paradox for its intractable process and below-expectation effectiveness over half a century (Barrett and Stanley, 1999). Although research findings and practical experiences continue to show a strong correlation between careful preparations and building sustainability, the inputs in terms of time, money and human resources at the project initiation stage are still scarce compared with the later phases.

2.2 Mega-Challenges

To curb the post-event epidemic, it is high time to identify the major challenges facing these event projects explicitly and implicitly, so that tailored prescriptions can be made and precautious measures be taken. Accordingly, challenges in six major dimensions are identified in the following.

2.2.1 Un-Ambiguity of Deadline

In terms of time frame, what makes event projects distinct from other regular ones exists in the non-negotiable 'event deadline' for the completion of all major on-site construction and related citywide renewals. Expo 2010 Shanghai China is a case in point with Table 1 showing the overall project schedule. August 19, 2006, which was 1351 days before the Expo opening on May 1, 2010, is marked as the inception of on-site construction of over 2,000,000 sqm within the boundaries of 5.28 sqkm Expo Site astride both banks of the Huangpu River. Citywide construction has also been in full swing, including six new metro-lines, significant expansions in airport terminals and train stations and other infrastructural upgrades. Although such a mega-volume construction may seem a "mission impossible" to most previous Expo host countries, the real challenge for its organizer is how to avoid the same old pitfalls of event legacies in the first three years of the initiation stage.

Table 1*: Timetable for Expo 2010 Project Development*

2004 Master planning, Pre-project preparation →	**2005** Detailed planning, Pre-project preparation →	**2006** Detailed planning, Urban design, Project programming, Design competition, Initiation of construction ↓
2010 Trial run for all on-site projects (prior to the opening date of May 1st, 2010)	← **2008-2009** Project design and construction, Trial-run for permanent building projects	← **2007** Site design, Detailed regulatory planning, Project design and construction

2.2.2 Sophistication of System

Because of their unusual physical scale, functional complexity and financial implications, major event projects are often achieved through interagency work at strategic, managerial and technical levels. In general, they are initiated by multiple government agencies or political groups, implemented by multi-headed state-owned enterprises or large-scale corporations, and supported by a pool of interdisciplinary consultants from well-reputed design and construction agencies. Such degree of project sophistication ranks the highest in the "Four degrees of sophistication" tool by Peña and Parshall (2001), which may easily incur value conflicts among stakeholders and exponentially increase the management work in terms of coordination, collaboration and cooperation.

2.2.3 Duality in Programming

The dialectical unity of temporariness and permanency in event architecture gives rise to a pressing issue of how to tackle the unique challenges of balancing the different programming priorities during and after the event. Although almost all types of built environment nowadays are in need of embracing the shifting demands originated from organizational changes in different time scales, no other attains the same extent as does an event building whose greatest uncertainties lies in their future capacities for use after the mega-events. As the initial step towards the making of architecture, programming holds the key to the whole project in that it both incubates a direction-giving action plan and serves as a constant evaluation tool along the project cycle. In terms of programming event projects, the top priority is to prepare for multiple alternative scenarios ranging from the zenith and the nadir in demand. When buildings are eventized according to different strategic emphasis and market orientation, they are prone to experience a roller-coaster ride as a result of the great margin between the peak and off-peak demands. There is ample historical evidence that the required capacity for purpose-built convention, exhibition, performance, sports venues or the like usually drop to its off-peak condition immediately after the peak capacity in the event duration. In order to stay competitive in the post-event era, event buildings have to keep a balance between "stability and adaptability" (Emmitt, 2007). Hence, it is crucial to determine a rational design capacity as a trade-off.

2.2.4 Temporality of Organization

Time is an essential dimension not just for a building but for its client. Contradict to the relative permanency of major event projects, the intrinsic disadvantage of their client organizations is that they are not only multi-headed but also short-lived. Urban renewal schemes and World Expos, which are to be developed in a continuous mode, are among those large operations easily suffering from disjointed multi-agency efforts on a short-term contract (Lynch & Hack, 1984). This is further verified by both literature evidence in previous Expos such as Seville 1992 Expo (Maddox, 2004), as well as Expo 2010 official reports on study visits and training summaries by staff members stationing in the most recent Expo organizations of Aichi 2005 Japan (Deng, 2004) and Hanover 2000 Germany. Assembled on a one-off basis for the event preparation, these Expo organizations are usually comprised of three groups of people, 1) public officials from established governmental agencies on a job-trading mission; 2) professionals hired from public recruitment programs; and 3) employees temporarily 'borrowed' from corporations or public institutions. Such multi-agency collaboration effort is limited to the preparatory and operational periods of the event and the joint force will be disbanded soon after the closure of the event, which may result in the loss of shared experiences.

2.2.5 Scantiness of Experience

Such discontinuity in knowledge sharing and transferring between previous organizers and their successors may very well lead to yet another challenge: insufficient databank as an initial reference point to draw upon. On the one hand, as one of the event concomitants, the physical legacies are endowed with in-replicability. All the related internal and external parameters are never the same, being it the organization, the stakeholders, the location and the functions in short and long range. Expo buildings are even devoid of a possibility for benchmarking in building types or technical parameters as those purpose-built sports venues for Olympic Games. On the other, there exhibits a lack of serious interest from the academic and professional arenas in this area, as most existing publications choose the visual side of event architecture, but seldom tell the stories of their formative stories behind those pictures. This results in an insufficiency, if not a total absence, of a readily accessible pool of literature and expertise worldwide. Empirically, such an awkward moment came in the early preparation stage of Expo 2010 when the author's team was working on the long-list of an international jury for an high-end design competition. We soon ran out of the candidates to fill up for the quota for domestic jury members, simply because it is the first time for China to host such a world event and there is a significant lack of experience and expertise in Expo projects among construction professionals.

2.2.6 Lack of Reference

Event organizations have to brace themselves for more un-precedentedness originated from the event itself, which make it distinct from those established organizations with readily available rules and regulations to follow. The fact that one-off mega-events occur outside the regular practice of routine organizations makes the above challenges boils down to a fundamental one for future event project clients: how to cope with the greatest level of risks and uncertainties embedded in building eventization. In this connection, great emphasis shall be put on how to establish a mechanism to enhance the performance of programming.

3. ACADEMIC LACUNA

Despite the mega-failures originated from a dearth of overarching visions beyond the events on the organizer side, academic interest in the domain of programming event projects has long trailed its significance, resulting in an absence of a readily accessible pool of literature and experience both within and outside China. Much of the previous research in programming has been stuck in an arguably long journey in search of technical programming models from the designer side of the 'aisle', while study on how to manage the process from the client side of the 'aisle' remains largely untouched. In the literature concerning how to improve the performance of the initiation stage and the programming process, there is especially a tendency in avoiding to discuss the client impact, which is very improper as decision-making within the client organization during the initiation is also critical to the success of a project. In fact, both the early stage and the client decision-making mechanism are paramount and devoid of discussions of either will end up with a partial and biased conclusion. This may explain why the past half century has witnessed an increase in the number of innovative approaches but not a proportionate increase in their effectiveness.

3.1 Programming Management

Accumulatively, here comes a highly-noticeable yet not widely-noticed vacuum at the intersection: *programming management* for large-scale event projects has gained very limited, if any, attention. The most likely reason for this might originate from the contradiction of the two related research areas. While most previous programming studies put focus on improving the process by standardized checklists and prescriptive 'best practice' models in a technical sense, event-initiated buildings have much more implications of the client organization on the strategic level. The volatility of the topic lends itself to easy negligence, as it appears more difficult to generalize a pattern for future applications.

Unlike other well-established management interests in such areas as project, design or facility, the term programming management is specially coined to underscore the significance of looking at the process from the client's perspective. In other management issues, a design manager, a project manager or a facility manager will be appointed for respective managerial roles on behalf of the client organization. Nevertheless, as the initiator, coordinator and ultimate decision-maker for a project, the client has to take the lead in the formulation process of defining, refining, implementing and evaluating the program. Moreover, the communicative nature of programming gives rise to the necessity of a consciously structured mechanism to steer the process in that most related activities are widely dispersed, loosely structured and oftentimes unconsciously conducted among multi-stakeholders in overlapping stages. Therefore, the key roles of programming management lies in the many and varied interfaces, including deconstruction of multi-dimensional processes into independent working units and areas of responsibilities, identification of all key 'joints' for sub-contracting or outsourcing, setup of switching points and timeframe for both strategic decision-making and operational guidelines, and systemization of all sub-processes for an integrated solution.

4. SHANGHAI, EXPO 2010 AND THE BIG4

Although the problems and challenges embedded in programming event projects are global, the management response has to be tailored to the local situations. In view of the intricacy of large-scale event projects and their implication to the construction system, it is not a simple answer to transplant foreign theories into Chinese practice. This leads to a need to embark on a glocalized research for the future operation in general and for China in particular. A case to serve this duality is the Big4 public building projects of Expo 2010 Shanghai China.

4.1 Riverfront Renewal Trilogy

Figure 1: *Pre-construction site view from Pudong (River East) overlooking Puxi (River West) with the vista of Lujiazui Financial and Trading Zone (as of May 2006)*
Photo credit: Bureau of Shanghai Expo Coordination

Previously hailed as the 'Oriental Paris' for its glamorous international history as well as the cradle of China's early industrialization, Shanghai has long faced with the same pressing issue of post-industrialization as many other cities around the world. With an ambitious goal to re-image itself as a rising global center, the city unveiled a staggering scale of urban renewal practices since the early 1990s, and has since then witnessed a steady growth in the number of events. This in turn justifies a massive new construction and expansion of existing public facilities for conventions, exhibitions, performing arts and museums. A popular vocabulary in the epoch of city imaging, the strategic alliance between staging an Expo and stimulating an urban renewal program is nothing new, as Seattle 1962 Expo was marked as the beginning of "the city renewal" era (Hall, 1992) in the World Expo history. Nevertheless, for the incoming Expo 2010 - the first World Expo themed on city and hosted by a developing country, the idea may be inherited but the scale is unprecedented; so is the affiliated high risk, were the whole scheme not well thought through.

The Huangpu River has witnessed a 19th-century Bund in the River West and a 20th-century Lu Jiazui Financial and Trading Zone in the River East. Distinctive from the previous two high-profile waterfront developments, the 21st-century Expo is strategically sited along both banks of the River to seek a more balanced outcome, which not only echoes the national campaign for social harmony but undoubtedly will be trend-setting in the riverfront development trilogy. Themed on 'Better City Better Life', the top priority for the Shanghai Expo construction is to knit the short-term master plan of the Expo into the long-term urban development strategy beyond the Expo.

4.2 Research Focus and Angle

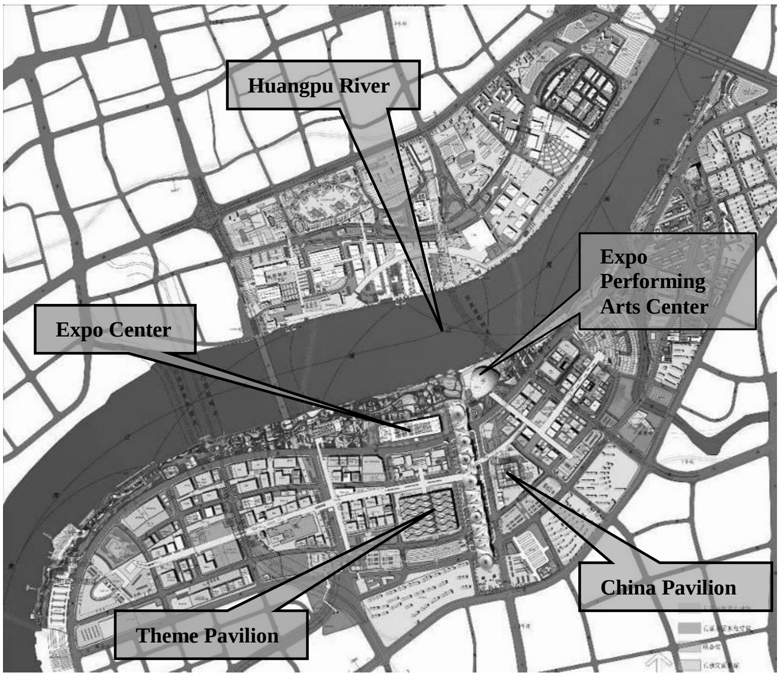

Figure 2: *The Big4 in the planned permanent zone of the Site of Expo 2010 Shanghai China, (updated as of January 2008)*
Source: Adapted from Shanghai Urban Planning Administration Bureau and Bureau of Shanghai World Expo Coordination

Accordingly, this explains why the research work mentioned at the beginning of this paper pivots on the dualism issue of programming management unique to the flagship of Expo 2010 construction - the Big4. Totaling some 500,000 square meters of floor area and strategically grouped in the core zone of the Expo site, the Expo Center, the China Pavilion, the Theme Pavilion, and the Expo Performing Arts Center will set the tone for redeveloping the site into a leading convention, exhibition, commercial and entertainment hub in the post-Expo era, as an integral part of the city's priority waterfront renewal program (Deng, 2005, 2006). By bringing the client organization to the spotlight, this research aims to come up with a framework plan with specific operational guidelines which can hopefully manage, if not fully address the current concerns for future practices, as well as to raise awareness of long-neglected programming education and a newly-emerging service gap.

4.3 Challenges for the Big4

Prior to the planning and programming of the Big4, a survey concerning the existing comparable facilities in Shanghai and around the world was conducted by the Expo Organization where the author worked as a project coordinator. The result shows a surprising high rate of dysfunction and idleness of space among large-scale convention, exhibition and performing arts centers in Shanghai, with the resultant huge expenditures in operations and maintenance. Many become incompetent, since their fixed building programs formed years before have excluded the slightest possibility of convenient and inexpensive spatial re-arrangements to cope with the increasingly sophisticated and stratified user demands in the competitive market. A lack of elaborate programming research prior to the actual construction stands out among other reasons.

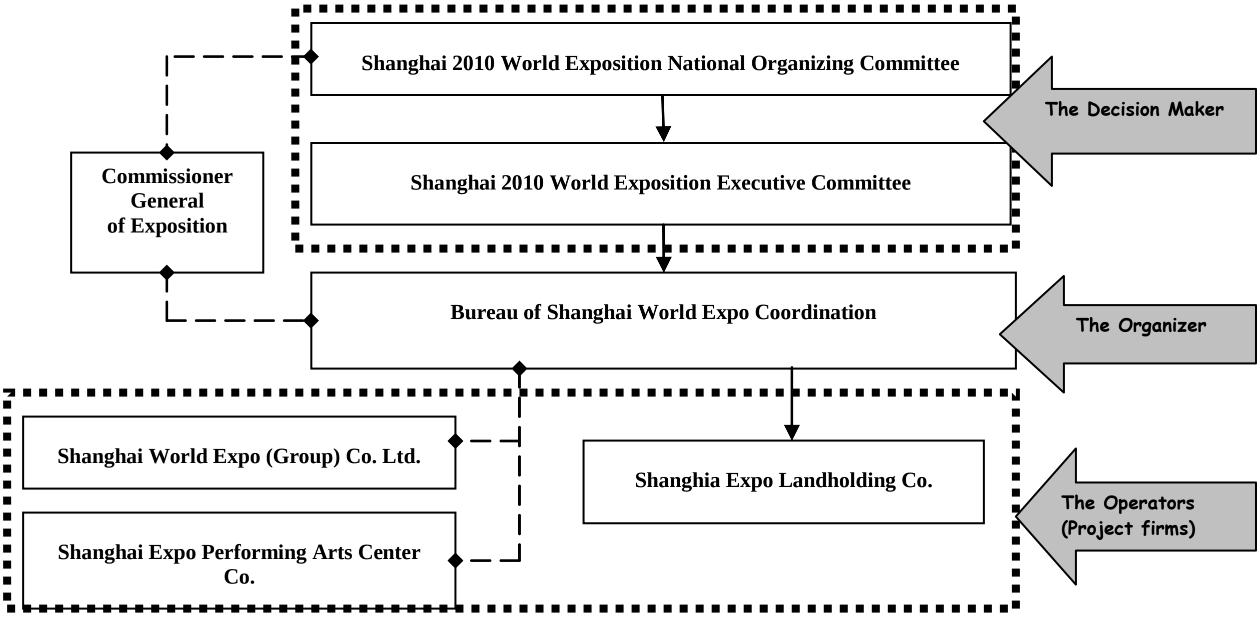

Figure 3: *Three-tier Organizational Structure of Expo 2010 Shanghai China*
Note: *Hierarchical* *Not strictly hierarchical*

The process of programming the Big4 started as early as that of master planning of the whole Expo Site in early 2004, which is a valuable learning process for its twists and turns. In retrospection, the process has drawn upon the expertise and experience of individuals and organizations from both public and private sectors at home and abroad, thus providing a precious opportunity for all interested parties to communicate with each other for a better understanding of the client's needs. Unlike most other temporary Expo facilities, the Big4 each has a dual program on a very considerable scale and with multiple stakeholders under multi-layered management systems. The three-fold unconventional challenges for them lie not individually but as a whole, which makes them distinguished from those conventional major projects.

Firstly, how to keep a good balance between the functional requirements in the Expo duration and immediately afterwards? Since some of the building programs may overlap, some may differ in scale but not in kind, and still others may totally disagree with each other, this dualism introduces a difficult task of making a seamless transition between a six-month event and sixth-year development. *Secondly*, how to program the four big 'neighbors' as a complement to each other in both aesthetic and functional aspects while still keeping their individual distinctiveness? Drawn from previous lessons, this is in response to serious concerns over juxtaposition of a bunch of 'landmarks' with duplicated programs in a compact district. To avoid similar mistakes and to achieve the long-term vitality of the future sub-center, the client's priority shall not only give to shaping a harmonious landscape with diverse architectural styles, but more importantly, formulating a clearly-envisaged development strategy with operational programs. *Last but not least*, since routine project approval system is single-project oriented, the challenge from the organizer perspective lies in how to deal with the un-precedentedness in processes and procedures.

One the one hand, to ensure the mega-scale five-year preparation and the six-month Expo operation, a three-tier system in strategical, managerial and operational levels has been established by the Central Government in early 2004. As demonstrated in Figure 3, it consists of three major components: the Decision Makers, the Organizer and the Support Groups (Bureau of Shanghai World Expo Coordination, 2006). On the other, the substantial government involvement at national, regional and local levels will inevitably complicate the decision-making process, which makes it extremely paradoxical to draw a boundary line between strategic and tactical decisions during the limited event time frame. Accordingly, the emphasis on programming the Big4 is rather on the management, aiming at facilitating communication, coordination and cooperation among multiple stakeholders and providing sensible decisions based on such constructive discussion of project requirements in a timely manner. Through an in-depth investigation into the programming processes, the case study aims at establishing a programming management tool as an initial step to help future organizers to better handle event-initiated public buildings.

5. RETROSPECTION AND OUTLOOK

Retrospectively and paradoxically, the development trends of event projects and programming appear to have been gone by contraries during the same period of time. On the one hand, large-scale event projects thriving on economic prosperity would certainly consume much greater resources than their average-scale counterparts, and oftentimes occupy significantly large and strategically prominent urban areas as a branding tool for the city. Hence, they have potentially greater impacts on the cities and their inhabitants beyond the event. On the other, however, the development pattern of programming tends to be in contrary to that of economy, as demonstrated by the fact that programming has gained or regained some ground in lean time, but losing its appeal in boom time when the priority went to form-making as the cost factor was not of a great concern to clients.

While mega-events has been developed with indispensable linkages to the urban sustainability of their host cities, great care should be taken in achieving the maximum unison of building programs of these mega-projects during and immediately after the event, in order to shorten the transitional process, minimize the resource consumptions, and reduce the construction costs, thus making an intelligent balance between social, economic and environmental sustainability. As a specific domain of increasingly social, economic and political significance, large and complicated event projects call for careful management to balance between short-term and long-term programming in order to embrace a time of change with great uncertainties. As the problems of programming event projects are deep-rooted and structural, it is not easy to grab for quick fixes. However, the right catalyst can trigger a difference. To solve the chronicles, a much more profound attitude shift will be needed. Therefore, the current global economic meltdown may arrive in time as a much-needed event to cool down the mania for event architecture, to regain the edge for programming, and most importantly, to catalyze a fundamental change in the attitude towards the intersectional vacuum among interdisciplinary areas of research: programming management of event projects.

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Architectural Design Management – a practical reflection on the development of a domain

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ABSTRACT

Architectural Management has evolved from a small number of seminal works published in the 1960s into an important knowledge domain today. This domain is underpinned by a growing body of theoretical knowledge which is valued by practitioners for its contribution to the improvement of planning, design and execution of projects. In the Netherlands, for example, a substantial number of design management tools (over 75) were developed by the Architectural Design Management Systems (ADMS) programme of the TU/e over the past decade. Much of the international work on architectural management has been developed via the CIB's W096 Architectural Management, supported by a growing number of PhD thesis, academic papers and a small number of books. Architectural Management has expanded and changed in response to the demands of clients and users, the continuous growth in complexity of our built environment, and the focus on whole life cycle/sustainability issues. Concomitant with this is the need for better collaboration, communication and integration, facilitated by developments in ICT and a better application of management. The aim of the work presented in this paper is to concisely review the development of architectural design management to identify the most pertinent issues for researchers and practitioners. These are then discussed in the light of the current and future challenges facing the Architecture, Engineering, Construction (AEC) sector. The paper concludes with a framework for further exploration of specific aspects with the aim of further developing architectural management.

KEYWORDS
Architectural Management, design management tools, knowledge domain, research.

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INTRODUCTION

Architectural Management has evolved from a small number of seminal works published in the 1960s into an important knowledge domain today [Emmitt 1999]. This field as it was identified by Nicholson [1992] is underpinned by a growing body of theoretical knowledge which is valued by practitioners for its contribution to the improvement of planning, design and execution of projects. Much of the international work on architectural management has been developed via the CIB's commission W096 Architectural Management (published in conference proceedings), supported by a growing number of PhD thesis, articles in peer reviewed journals and a small number of books. From a review of the literature it is evident that architectural management has expanded and changed in response to the demands of clients and users [Bertelsen & Emmitt 2005; Lindahl & Ryd 2007], the continuous growth in complexity of our built environment [Gray & Hughes 2001], and the focus on integral design [Zeiler *et al.* 2009] and whole life cycle/sustainability issues [Mangent *et al.* 2009]. Concomitant with this is the need for better collaboration, communication and integration, facilitated by developments in ICT [Wilkinson 2005] and a better application of management.
The recently published book written by members of the CIB W096 commission, *Architectural Management: International research & practice* [Emmitt *et al.* 2009] provides useful background to the development of the discipline, while providing a number of insights into aspects of theory and application. The book is an important milestone for the commission, being the first published by the commission's members since its inception in 1993. The work could also be seen as an important catalyst for the continued evolution of architectural management. The aim of this paper is to review the development of architectural management by focusing on the output of the Architectural Design Management Systems (ADMS) programme at the University of Technology Eindhoven (TU/e) in the Netherlands. From this it is possible to identify some pertinent issues for researchers and practitioners and future trends for the development of architectural management – the theme of this conference.

POSITIONING – ARCHITECTURAL DESIGN MANAGEMENT SYSTEMS (ADMS)

Architectural Design Management can be regarded as a specific domain of knowledge in which the ADMS programme at Eindhoven University has gained knowledge and experience during the past 12 years. ADMS is one of the post-MSc technological designer programs of the 3TU.School for Technological Design, Stan Ackermans Institute. The aim of the 3TU.School is 'to maximize innovation by combining and concentrating the strengths of the three Dutch technological universities in research, education and knowledge transfer' (www.3tu.nl/en/). Graduates of a program receive the certificate PDEng (Professional

Doctorate in Engineering). Trainees for the program need to be approved to enter and will become a paid member of the University staff for two years. The 3TU.School is subsidised by the Dutch government and a programme gets a fee based on successful finalising of that programme by a trainee. Each trainee finishes with a nine months in-company assignment for which a company has to pay a fee based on the salary of the trainee and its guidance.
Since the inception of ADMS in 1996 a substantial number (over 75) in-company assignments were executed in which design processes on organizational and inter-organizational level of design teams for complex buildings and urban development were analyzed and processes were modelled by the use of business science methods [Aken *et al.* 2007], to improve effectiveness, efficiency and design quality. Architectural in this context is meant to focus on the design qualities of the built environment to which architectural designers and more specifically architects contribute.

In general, the target of the ADMS investigations are focused to analyze complex, real life design processes on perceived bottlenecks, and searching for causes and explanations to be able to solve the problem [Aken *et al.* 2007]. Problem solving within ADMS is focussed on redesign a design process by reordering and systemise a process, delivering a design management tool for a specific design organization. Complexity concerns both the technological complexity of the artefact, through to the design and organisational complexity of the project teams, which are configured for the planning, design and execution of the designed artefact. Process redesign concerns the systemizing, structuring and modelling of design processes or parts of that and the development of a management tool. These assignments concerns: (a) the execution of case-studies during the program (mostly executed in small groups), and (b) by the individual execution of the final in-company assignment. By performing such an assignment, a trainee has to show competences and abilities to execute such business oriented research independently, although coached by a scientific team. The assignments were executed for a variety of organizations and firms: large, well known architectural offices, combined architectural-engineering firms, consultancy firms, and advisory firms for building physics services and installations, project developers, care taking organizations, municipalities, county government, national operating real estate agencies and hospital related organizations.
Architectural design management needs to be recognized as an essential phenomenon in the project's business playing field of concerned, contracted parties and actors in the planning and design process for new accommodations of organisations: clients and users. The corners of this playing field, as ADMS recognizes and discriminates [Otter 2008], are: client(s) and users; management of the project; architect(s) and specialist designers; building contractor and sub-contractors (see Figure 1). In the playing field, project management is identified as a party holding a specific corner in the field, which acts depend on the configuration of the design

team and the contract for collaboration between the different parties and actors to achieve the project goals within limited time to an agreed budget. Architectural offices usually deal with design management depending on their capacities, competences and the contract with the client for delivering services [Emmitt 1999; DNR 2005]. It is not uncommon for clients to hire project managers that are independent from the other stakeholders (architect and contractors), to act as the client's representative [Gray & Hughes 2001].

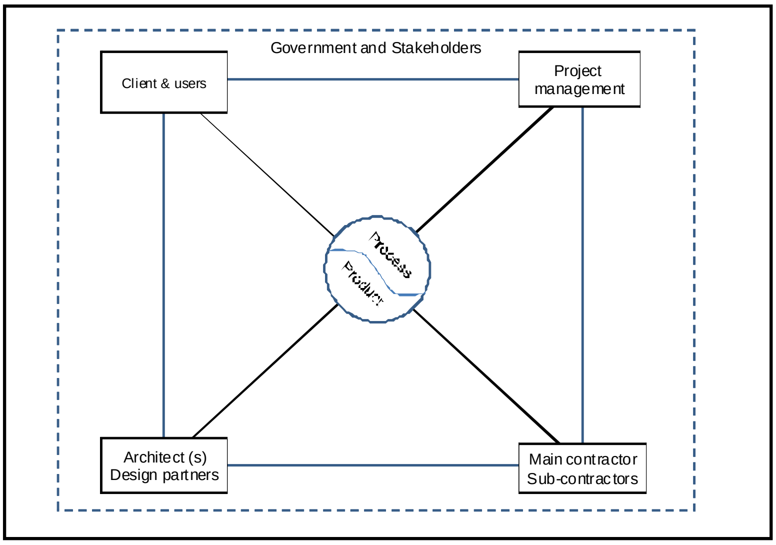

Figure 1: *Playing field of collaborating parties in building and construction*

Large architectural offices mostly have the capabilities to perform architectural and project management tasks. Balancing between design and project management tasks is necessary in such collaboration as the planning and realization of the Luxor theatre in Rotterdam [Demmers *et al.*1998], the planning and redevelopment of the Glass palace Schunck in Heerlen [Friedl *et al.*1999] and more recently the redevelopment of the Westraven offices in Utrecht [Erkelens *et al.* 2005] and the development of the Mosa Forum in Maastricht [Beckers *et al.* 2008]. In the playing field the circles of design object and design process are overlapping and might conflict in concern and interest [Doorn *et al.* 2005]. Within this approach, on the diagonal connection between the design and management corners, the interest field of design management can be discriminated (Figure 2). The line represents the connection between product (designer's corner) and the process (management corner) and focused both to the design content and to the collaboration, tasks and planning. A design process can be managed and controlled either by project managers or by designers having management tasks, depending on the position, responsibilities and task of a design manager [Gray & Hughes 2001; Hendrata & Scheltens 2003]. The overlapping field in the middle is a symbolic reproduction of the conflict in the management view that might appear due to differences in approach by a project manager and a design manager both dealing with design problems and possible solutions from a different viewpoint and working for different organisations with various concerns.

Project management and managers tend to lower uncertainty and risks in the beginning of the design process, using decision making to get more clearly sight on the result while design management and coordinators in general are dealing with iterative design processes searching for the best opportunities and increasing architectural values [Prins 2009]. Such processes are focused to the artefact to design, searching for better insight to the Client's brief and expectations, first developing concepts to derive a better insight in the object to be designed and how to deal with it from newly derived perspectives. The linear time oriented decision making process create tension with the iterative design process as Figure 2 shows. Specifically, in teams configured for integral design in which the sharing and accumulation of knowledge, communication, negotiation and visualizing ideas, tuning of design, and team stimulation are essential for successful results [Emmitt & Gorse 2007; Goossens 2008].

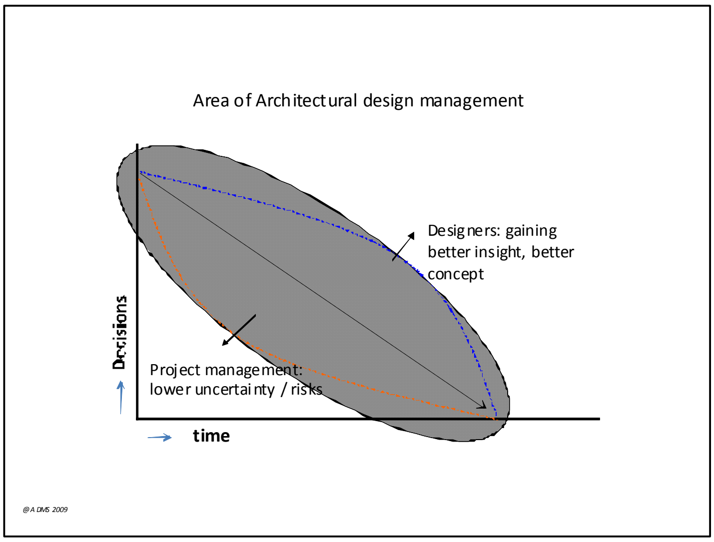

Figure 2: *The area of architectural design management*

DESIGN MANAGEMENT ON ORGANIZATIONAL AND INTER-ORGANIZATIONAL LEVEL

On an inter-organizational level, investigations of the functioning and management of multidisciplinary design teams were performed for six different companies: a real estate agency, a governmental agency on regional level, a consultancy firm, one of the largest project management companies in the Netherlands, a healthcare firm and for one of the professional research boards in the Netherlands in cooperation with a consultancy firm. Compared to the in-company assignments ADMS delivered in the first five years (1998-2002), a move in subjects and companies occurred. In the first five years assignments were performed in the area of ICT use on organizational and inter-organizational levels, yet no assignments regarding ICT were executed in the following five years [Otter *et al.* 2007; Achten *et al*. 2008].

A shift in focus can be observed to the inter-organizational level and for companies operating in the early design phases for starting a project. During the early years a lot of contracts and collaboration were based on the traditional contract model between the client and its main participants. A contract usually was made with the architect and the building contractor. In most large, complex projects an independent project management company was contracted by the client. In such multi-disciplinary projects the collaboration between the architect, the project management firm and the building contractor usually was not based on a contract (Figure 3). The in-company assignments executed during the last five years show differences concerning contracts and collaboration. No focus to ICT use and assignments on organizational level, but much more organizations and companies, who operate in the early design phases for initiating projects, defining the program and configuring the team using various types of contracts [Erkelens *et al.* 2005]. The traditional triangle, centred to the client and users of the facility is changing in large, complex projects. Instead of centring to the client it is management oriented.

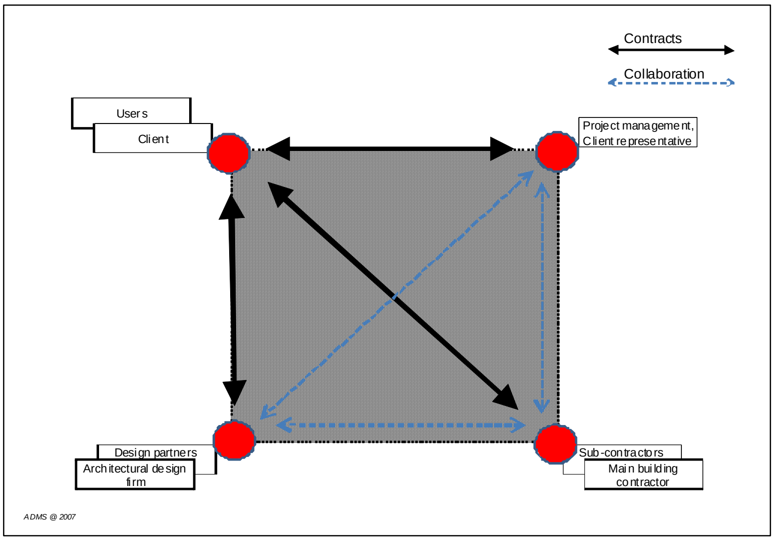

Figure 3: *Traditional contracting and collaboration*

CHANGES IN CONTRACTS, MANAGEMENT ORIENTED

Project development nowadays gets more focused to deliver design concepts or to deliver products based on repetition and variation on a basic product concept. Development focusing to the organization of the project in the early design phase, for delivering well studied concepts with high architectural values and new scenarios for project private partnerships to deliver and maintain the product during the life cycle. Project development, focusing on variation and repetition of basic concepts, try to optimize the detailed design and the execution of the product using contract forms like design & built or performance based building, but also on DBFMO; Design, Built, Finance, Maintain and Operate [Berning 2008]. Figure 4 shows that such contracts totally change the configuration of teams, their responsibilities and roles, due to the differences in the business case as Gray & Hughes [2001] defined. This also reflects on the different role and responsibility of the Architectural firms involved in such. Also the building's life cycle became an issue during the past years and needs better planning at the start as well as better organizing the realization of the product and contracting participants that are able to provide life cycle services.

Regarding the opinions of the ADMS external advisory board, this change in organizing design and build processes will be intensified in the near future [Otter *et al.* 2007]. This also means that future ADMS assignments might also be executed in the new triangle of design, focused to the capabilities and possibilities the producing firms offer as Figure 4 shows.
The assignment concerning 'Creating spaces of great value' [Jansen Klomp 2008] executed for Rabo Vastgoed and the 'Manual for DBFMO tender procedures' [Berning 2008] executed for Arcadis are examples of such change that will also need investigations and analyses how to stimulate changes in the traditional building culture and how to intensive collaborations between the partners in such projects and contracts. Public private partnerships with a focus to privatizing public spaces, integral design approach with collectively used ICT on both the inter-organizational and organizational level might be subjects for such assignments.

POSITIONS AND RESPONSIBILITIES

Based on the above, it can be concluded that design management need to be identified better as a professional task and role that can be performed independently by a party that is hired by the client, or part of a project management task or as a specific task and role in an architectural office or design specialist firm as Figure 5 shows.

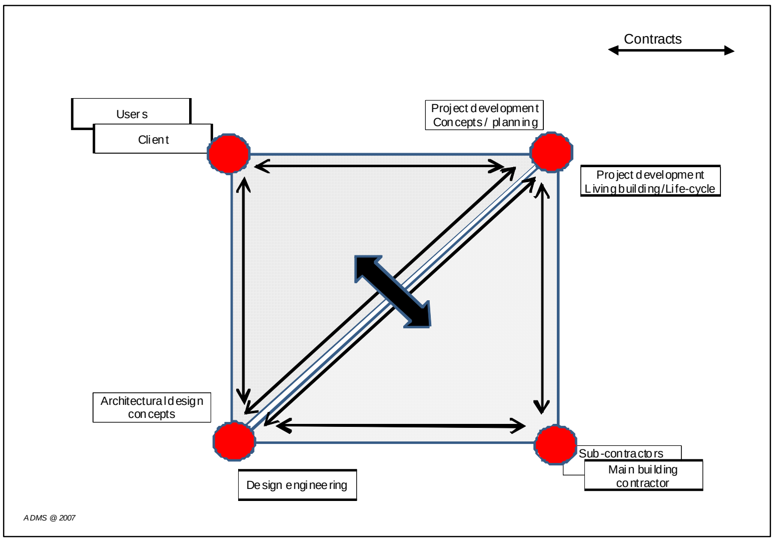

Figure 4: *New contracts and collaboration oriented to management*

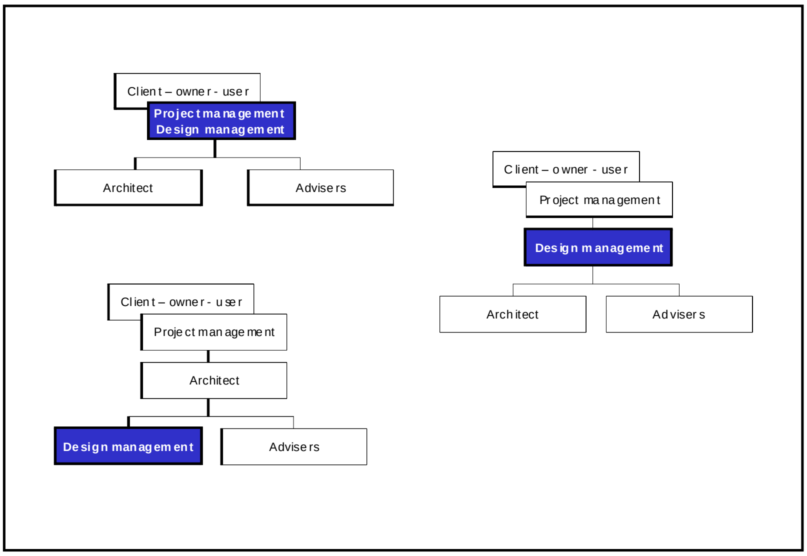

Figure5: *Positions of Design management*

By improving conditions and appointments by which a design is performed, a situation can be created in which all design participants will optimize their contribution to the design, instead of creating a bureaucratic, too much management tools focused environment of planning, deliverables and costs. In this vision, risk management is viewed at to be a challenge to get the best of the team within the setting of constrains for complex building and construction projects instead of a bureaucratic, paper environment of checklists [Doorn *et al.* 2005].

So, it can be concluded that it is important to prevent project management in the building and construction industry to become too much a checking organization to design organizations involved. Too much attention for the logistics of planning and linear progress of design instead of focusing to understanding, supporting the creation of synergy in design tasks of the various design partners involved to increase design values. Design management in large design firms and architectural offices partly easily becomes a task of the architects because of their close relation to the client; however they might delegate such tasks for quality purposes and for better tuning of the various design tasks of employees working sequent on more than one project.

EVALUATION OF THE ADMS DESIGN MANAGEMENT TOOLS

In 2008 ADMS conducted an evaluation into the implementation of the design management tools developed by the ADMS trainees for their clients in the period 2003-2007. Thirty five firms were visited and interviewed. The evaluation was executed by a former member of the ADMS external advisory board by means of semi-structured interviews that were verefied afterwards with the respondents. The advisory board is a critical platform for the program and the eight external members are representatives of well known architectural design firms, engineering and management firms, advisory firms and main contractors. The results of evaluation show that 40% of the tools was implemented succesfully and 35% was partly succesfull implemented. The tools developed on organizational level were most succesfull implemented. The results show a high score compared to other innovation projects in Dutch building and construction. However, for 25% of the tools developed the implementation failed mainly due because the tool was developed to solve a problem on inter-organizational level that is hard to solve and implement in such temporary organisations.

The evaluation results also showed that most firms discovered through the assignment what architectural design management really is about, and admitted that their view on the assignment at the start was poor. To improve this and to avoid misunderstanding by clients of the assignments, the ADMS management team now meets with the client more intensively at the start of the assignment, to explain and assure their client that such an assignment need to be regarded as an innovation for the firm that will change present tasks and processes. In this view the assignment is the start of an innovation project that need to have a project manager in the firm who also is responsible for the implementation of the tool developed by the ADMS trainee. Also discussed at the start is the type of guidance needed for the assignment and the workload for the firm.

CONCLUDING OBSERVATIONS

Based on the experiences gleaned from the ADMS programme it appears that the performance of design management is greatly dependent on the size and complexity of the project, the configuration of the team, and the design management competences of the architects.

Although doing business research is important within the ADMS programme to gain insight into complex planning and design processes, it is first and foremost an educational programme focussing on educating young high performers. By teaching them how to gain the right competences in the field of architectural design management enabling them to analyse, diagnose, reorder and model design processes affecting design quality. Gaining the business knowledge, skills and abilities to model design processes and to perform well in the design process as a responsible party is paramount. Through such education and the evaluation of the implementation we have found that designers can perform better because of greater insight and knowledge of design processes of complex building and construction projects, supported by knowledge of the latest business science developments relevant for building and construction projects. The evaluation of the implementation also showed the successfulness of such innovation in practice.

The authors' experience, combined with feedback from the ADMS trainees, suggests that there is a need for more and specific literature on architectural management. Obvious areas in need of further development and articulation relate to:

(i) the philosophy and theory underpinning architectural management, and
(ii) appropriate tools and their application.

Many of the case studies performed by the ADMS students have potential to be published in English, and this is one area that could help the continued development of the architectural management knowledge base. Early work on architectural management has helped to establish the domain. Future work should seek to explore in greater depth the theory and application of architectural management as a distinct domain. In this regard, CIB-W096 Architectural Management has a role to play in guiding and stimulating future research and engaging practitioners and educators to discuss and share good practice in architectural management.

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SECTION 5

APPLICATIONS OF ARCHITECTURAL ENVIRONMENT CONTROL AND MANAGEMENT TECHNOLOGIES

Evacuation Safety Countermeasures for the 3-Rail Co-construction of Taipei Main Station

Wei-Wen Tseng[1]
Tzu-Sheng Shen[2]
Shiue-Shian Kao[3]

.**Abstract**

Taipei has become an important international city in Taiwan. The Main Station in Taipei is not only the busiest train station, but also the most important traffic hub in the Taipei area. Due to ongoing infrastructure development, the modern 3-Rail Co-construction of Taipei Main Station combines Taiwan Railways, High Speed Rail and the Taipei Rapid Transit System. In the near future, the Airport Express System will also join this hub construction. Such co-constructions are characterized by large-scale spaces, complex relationships between connective gateways, extremely high densities of passenger numbers, long and confused transit distances, multi-user occupancies and large amounts of combustible materials etc.

If Taipei Main Station were to suffer a fire, the confined underground spaces, which are distinguished by insufficient natural light and ventilation, would cause high temperatures with thick smoke. This would result not only in a large number of casualties and property loss, but also to equipment failure and structural damage that may cause serious interruption to the station's operation. Due to its preeminent position in Taiwan's transport infrastructure, any interruption to operations at Taipei Main Station will have a serious impact on the society and economy of the whole country.

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From the viewpoints of life safety in such a large-scale construction and its organizational complexity, this study selected the U2 platform level as the review object for floor and total evacuations respectively, i.e. evacuating from two storeys underground to ground (street) level. This study also used buildingEXODUS and Fire Dynamic Simulation (FDS) as simulation tools to analyze evacuation situations in fire hazards. The main purpose is to identify the evacuation problems and provide some countermeasures in response to these problems to be used in this critical infrastructure.

Keywords:

Taipei Main Station、3-Rail Co-construction spaces、Evacuation Safety、buildingEXODUS

1. Introduction

Intense commuter traffic in the urban center has led to the increasing use of public transportation systems in the central business district. In the past, railway crossings interrupted the smooth flow along the city streets, causing obstructions on the roads and leading to a worsening of the urban traffic congestion. To overcome this problem, part of the passenger platforms and tracks have been relocated underground, which not only prevents the railway crossings from impeding traffic, but also makes large tracts of land available for development, thereby improving traffic and advancing urban growth. However, the location of the railway facilities underground complicates the traffic mechanisms, while the large amount of users can be a potential hazard in the event of a fire, making fire-fighting and rescue efforts difficult. Therefore, research on emergency escape is important in assuring the safety of the public.

Taipei Main Station is designated as a special structure by the Executive Yuan, with its safety measures as per the stipulations of National Fire Protection Association. After being in use for over two decades after its completion, the station has seen its layout changed many times due to ongoing infrastructure development and is now considerably different from the original design as shown in figure 1-1 and 1-2. It is therefore important to examine the relationships between the characteristics of the layout and use of the key elements of the interior space and emergency escape routes. This study selected the U2 platform level as an example review object for floor and total evacuations respectively, i.e. evacuating from two-storeys underground to ground (street) level. This study also used buildingEXODUS and FDS as simulation tools to analyze evacuation situations in fire hazards. The main purpose is to identify evacuation problems and provide some countermeasures in response to these problems, which can be used in this critical infrastructure. Finally, relevant suggested improvements are proposed based on field surveys.

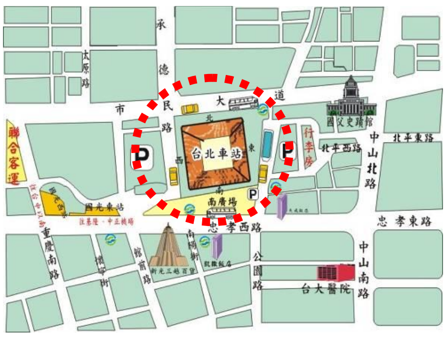


Figure 1-1. *The location of Taipei Main*
（Source：Taiwan Rail Administration）

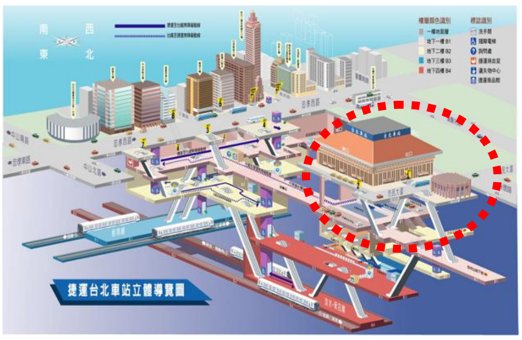


Figure1-2. *A Cross-sectional view*
（Source：Taipei Metro）

2 Transportation spaces in Taipei main station（G1、U1 and U2 level）

The station itself is a large building which houses multiple rail services, the headquarters of the Taiwan Railway Administration as well as conventional services spaces. The railway platforms are located on the U2 level, while the U1 level serves as a concourse area. Ticketing services are on the first floor while the second floor contains a food court and several stores, named Breeze Taipei Station. The upper levels from the third to seventh storey are offices.

The ground floor (G1) in Taipei main station is the refuge floor, i.e. all underground spaces are to be evacuated through this floor to the outdoor areas. The concourse floor (U1) connects five underground shopping streets including Taipei, Zhongshan, New World Shopping Plaza and Front Station respectively. The U2 platform layer is used jointly by Taiwan Railway and High Speed Rail, with four emergency stairs located in both sides of the 2nd and 3rd platforms. The floor plans of the transportation spaces are shown in figures 2-1, 2-2, and 2-3 respectively.

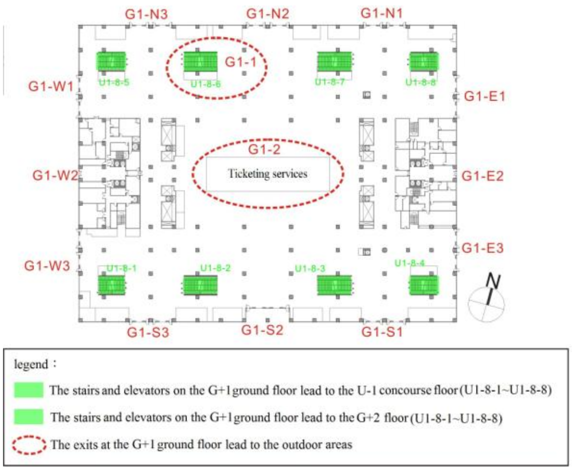


Figure 2-1: G+1 Ground Floor Plan ***Figure 2-2:*** U1Concourse Floor Plan
(Source: UNION PROFESSIONAL GROUP SAFETY CO., LTD)

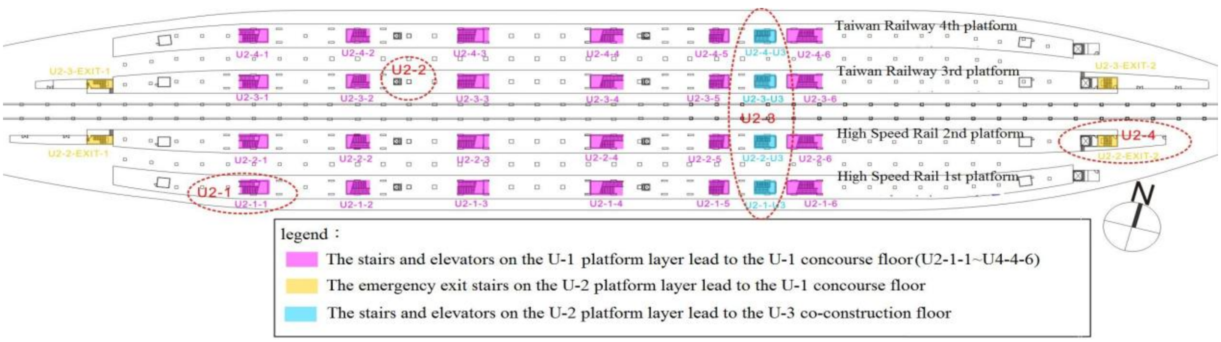


Figure 2-3: U2 Platform Floor Plan
(Source: UNION PROFESSIONAL GROUP SAFETY CO., LTD)

3 Analysis of the inside personnel

To better appreciate the problems for emergency evacuation, it is necessary to understand the Required Safety Egress Time (RSET) for U2 floor evacuation. Due to lack of passenger gender, age and volume statistics for Taipei Main Station, this study derives related parameters for buildingEXODUS from the Taiwan census to estimate the proportions of different passenger characteristics in the station. The Taiwan statistics website in January 2008 showed the total population, from 0 to 100 years old, as 22,966,459, with the numbers of males and females 11,611,026 and 11,355,433 respectively. The average life expectancy for males is 73.4 years old and 79.1 years old for females. If pre-school children aged 0 to 9 and the elderly over 80 are excluded then, with a ten year segmentation, the distribution of males and females, with a total number of 20,054,640, is shown in Table 1.

Table 1. the proportion of people of all ages in Taiwan

Gender	Number	Percentage	Gender	Number	Percentage
Male age 10-19	1,686,110	8.4	Female age 10-19	1552854	7.7
Male age 20-29	1,878,464	9.4	Female age 20-29	1805629	9.0
Male age 30-39	1,864,141	9.3	Female age 30-39	1849157	9.2
Male age 40-49	1,893,148	9.4	Female age 40-49	1871237	9.3
Male age 50-59	1,497,831	7.5	Female age 50-59	1520136	7.6
Male age 60-69	741,925	3.7	Female age 60-69	799058	4.0
Male age 70-79	538,562	2.7	Female age 70-79	556388	2.8
Male total	10,100,181	50.4	Female total	9954459	49.6
※total number　20,054,640人					

Source：National Statistics, Taiwan, http://www.stat.gov.tw/mp.asp?mp=4

In addition, to simulate the worst-case scenario, the first step is to estimate the total number of evacuees in relation to the transportation capacity at rush hour. The relevant information for Taipei Main Station is described as follows:

(1) The rush hours in week days are 7:30 to 9:00 and 16:50 to 19:00, and in the weekend, and holidays generally, from 08:00 to 09:00 and 17:00 to 18:00. It is very important to plan emergency responses for the operation management of underground stations during rush hours.

(2) Regarding the calculation of floor evacuation time, the first step is to estimate the transportation capability in the station during rush hours. The daily and hourly transportation rates have been provided as follows:

A. The hourly and daily transportation rates on weekday rush hours

(A) Tai Rail in Taipei station hourly ＝ 14,943 (people/hr)

(B) Tai Rail in Taipei station daily = 79,611 (people/day)

B. The daily and hourly transportations on weekend rush hours

(A) Tai Rail in Taipei station ＝10,405 (people/hr)

(B) Tai Rail in Taipei station ＝64,054 (people/day)

Taking platform four (northbound) of Tai Rail in Taipei Station to calculate the passenger capacity as an example:

A. The waiting number of passengers on the platform

(A) The ratio of passengers heading north on the platform: 160/315 ＝ 0.508 (Tai Rail has two platforms - 3 and 4, southbound and northbound, respectively - with the number of scheduled trains 315 and 160 respectively)

(B) The number of passengers entering the station during rush hours = 7,430 × 0.508 = 3775 persons (0.508 is the ratio of passengers heading north)

(C) Per 15 minutes in rush hour 3775/4 * 1.3 = 1227 persons (1.3 is the adjusted factor)

(D) Waiting passenger capability 1227/15 * 12 = 982 persons or 1227/15 * 5 * 2 = 818 persons, so select the max 982 persons

B. Train carrying capacity

(A) Hourly carrying capacity during rush hours = 14,943 × 0.508 = 7592 persons

(B) Carrying capacity during rush hours per 15 mins = 7592/3 * 1.3 = 3290 persons

(C) 15/5 = 3 scheduled trains per 15 minute interval

(D) 3290/3 * 2 = 2194 persons

(E) carrying capacity of a train = 800 persons

(F) 2194 > 800 = 2194, so select the max 2194 persons

C. The transportation capability on platform 4

(A) The transportation capability number = waiting passengers + carrying passengers

(B) Carrying passengers = 2194 persons

(C) Waiting passengers = 982 persons

(D) Total = 3176 persons

(E) platform 4 area is around 2378.68 ㎡ (excluding control rooms, staircases, elevators), so the occupancy density is 3176 ÷ 2378.68 ＝ 1.335 (persons/㎡)

Following the above estimation and referring to NFPA 130 [National Fire Protection Association, 2003], the numbers on platforms 1 and 2, for High Speed Railway, and on platforms 3 and 4 for Tai Rail is approximately 1155, 1155, 3076, and 3176 respectively. The distributions of gender and age used for the computing evacuation model in this study are based on the Taiwan population statistics, whereby the male to female ratio is 50.4% to 49.6%, and the largest proportion of the population is men and women aged from 20 to 49 years old as shown in table 2. The buildingEXODUS software randomly generates attributions for each evacuee group as shown below in Table 3. [Ed Galea etal, 2000]

Table 2. The proportion of the population used in buildingEXODUS

Gender	Percentage	Number	Gender	Percentage	Number
Male age10~19	**8.4**	719	Female age10~19	**7.7**	659
Male age 20~29	**9.4**	805	Female age 20~29	**9.0**	771
Male age 30~39	**9.3**	796	Female age 30~39	**9.2**	788
Male age 40~49	**9.4**	805	Female age 40~49	**9.3**	796
Male age 50~59	**7.5**	642	Female age 50~59	**7.6**	651
Male age 60~69	**3.7**	317	Female age 60~69	**4.0**	342
Male age 70~79	**2.7**	231	Female age 70~79	**2.8**	240
Male total	**50.4**	4315	Female total	**49.6**	4247
					※total number 8,562人

Table 3. Random attributions provided by buildingEXODUS

Attributions	**Average**	**Min.**	**Max**
Male	4315	4315	4315
Female	4247	4247	4247
Age	44.34	10.00	79.00
Agility	4.71	2.03	7.00
Drive	9.20	1.00	14.97
F.Walk (m/s)	1.35	1.20	1.50
Walk (m/s)	1.21	1.08	1.35
Crawl (m/s)	0.27	0.24	0.30
Leap (m/s)	1.08	0.96	1.20
Mobility	1.00	1.00	1.00
Patience (s)	3.06	1.00	5.00
Response (s)	14.63	0.00	29.98
Weight（kg）	65.12	40.02	89.99
Height（m）	1.60	1.20	2.00

4. Incident Scenario

4.1 Case Study

It is almost unheard of in Taiwan to have a man-made incident like the London subway terrorist attacks. However, with the rapid pace of life and the demands of a fiercely competitive work environment, people living in modern Taiwanese society are often risk psychological distress. The resultant mental illness has the potential to lead to a malicious offensive, which could result in an incident similar to the South Korea Daegu subway fire.

On February 18, 2003, as the train left Daegu Station around 9:53 a.m., a passenger (who was a mental patient suffering from depression) began fumbling with cartons containing liquid and a cigarette lighter, alarming other passengers. As other passengers struggled to stop him, one of the cartons spilled and its liquid contents caught fire as the train pulled into Jungangno Station in downtown Daegu. The arsonist, his back and legs on fire, managed to escape along with many passengers on train, but within two minutes the fire had spread to all six cars. The fire spread quickly in the insulation between the layers of aluminum that form the shell of the cars, the vinyl and plastic materials in seat cushions and strap handles, and heavy plastic matting on the floors, producing thick smoke as it burned. The operator of the train failed to notify subway officials immediately of the fire. A serious of failures led to 198 passenger deaths and 147 injuries.

4.2 Design Arson Fire

The transportation spaces in Taipei Main Station are located underground. The confined spaces and dense smoke are the main impediment to evacuation and fire fighting operations once a fire has occurred. High temperatures will also cause structural collapse and danger to life safety. This study refers to the Daegu subway fire in South Korea and selects the U2 platform level as the review object for floor and total evacuations respectively, i.e. evacuating from two-storeys underground to ground (street) level. The design fire set an oil pan on the rail lines to simulate an arson fire in a cabin. The main purpose was to analyse the life safety situation in such an arson induced fire.

All the parameters of the fire scenario and the boundary conditions used in the FDS are listed in Table 4. The dimensionless grid (D*) was used to analyse the mesh sensitivity and a 5 cm fine grid was adopted around the fire source. [Kevin McGrattan, et al., 2008] Eighteen detection devices are distributed along the 3rd and 4th platform in each stair and around the fire as shown in Figure 3. All devices are 1.8m in height from platform.

Table 4. Pparameters of fire scenario and boundary condition

◎ **Design**			
Fire Location	α	Fire Growth	Fule
Between Tairail 3rd and 4th platform (as shown in figure 3)	0.075	t^2 model & HRR up to 12MW then decay	Kerosene
◎ **Ventilation Systems**			
Items	3rd and 4th platform Inlet fans	3rd and 4th platform Outlet fans	U2 Platform Level Tunnel Jet Fans
Air changes	7.14m^3/s	2.89 m^3/s	9.11 m^3/s
Temperature	24℃	—	27℃
Condition	close	close	close

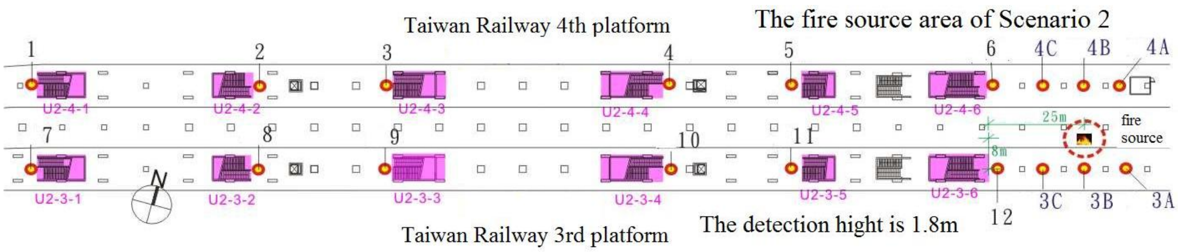
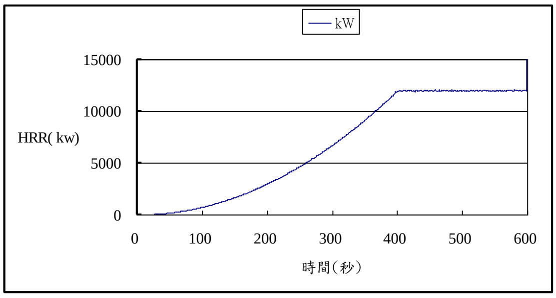


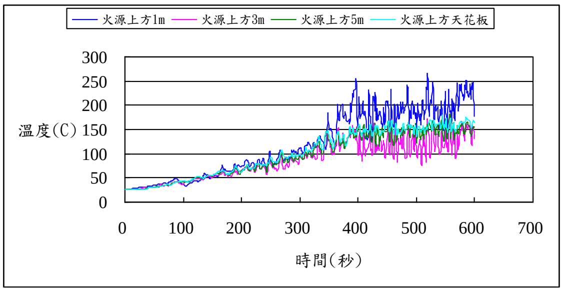
Figure 3. *The location of detection devices*

5. Simulation Analysis and Discussion

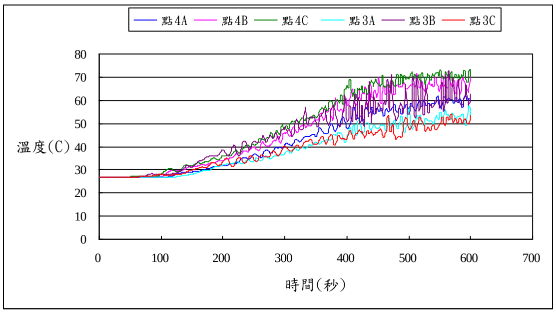
To simulate emergency evacuation in Taipei Main Station U2 platform level (total evacuation simulation) using buildingEXODUS, there are 362 passengers still trapped in a dangerous environment around U2-3-6 stair on the 3rd platform 400 seconds after (6 min. 40 sec.) the evacuation started. The majority of trapped passengers are likely to be in a heavy smoke environment, with visibility of less than 10 metres and thereby cannot see the evacuation path. Fear, tension and hesitation cause passengers to queue up around U2-3-6 to evacuate to upstairs. On the 4th platform, there are 183 passengers still trapped in a dangerous environment around U2-4-6 stairway 500 seconds after (8 min. 20 sec.) the evacuation started. The temperature around U2-4-6 stair is predicted to be up to 60 ℃ and the visibility is down to 10 m (see Figure 4). No one can survive in such an environment, exposed to the fire and its products. In other words, trapped passengers around U2-4-6 stairway will die due to failed evacuation after 500 seconds. We can conclude that there are around 545 casualties on both the 3rd and 4th platforms after 400 seconds and 500 seconds, considering the Available Safety Egress Time (ASET) with fire development by using buildingEXODUS



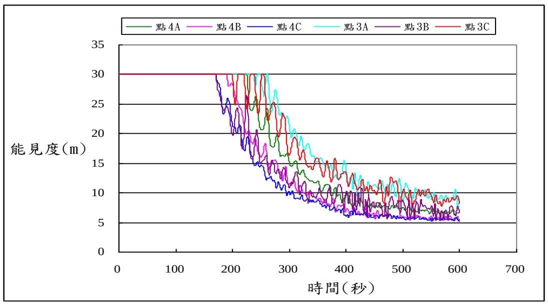
4-1. Heat Release Rate



4-2. Fire Source Temperature



4-3. Temperatures around Fire Source in 3rd and 4th platform



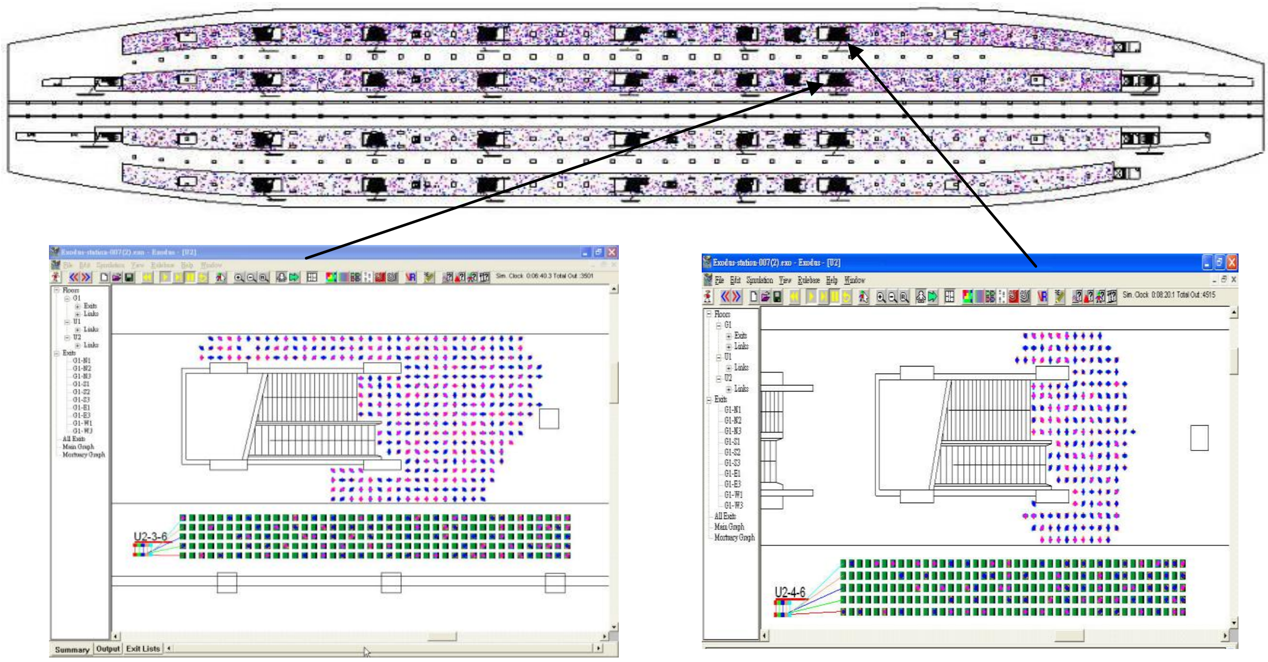
4-4. Visibilities around Fire Source in 3rd and 4th platform

Figure 4. *Fire Simulation by FDS*

As shown in figure 5-1, the passengers using the 24 stairs up to U2 entrance and exit lobby, the 3rd platform U2-3-6 stairway and the 4th platform U2-4-6 stairway may cause many trapped casualties that will obstruct the route for fire hose deployment, i.e. the 24 stairs on 4 platforms are not suitable in this scenario. The available escape routes located in the extreme ends of both sides of the 3rd platform, which lead directly to the ground, have always been ignored by evacuees because of inadequate lighting and miscellaneous goods around both emergency stairs. The queue nodes in U1 concourse level and G1 ground lobby are shown in Figure 5-2 and 5-3, respectively, once the total evacuation initiated. A resulting comparison of the different situations used, for floor and total evacuations respectively, in U2 platform is listed in Table 5.

Table 5. A result comparison with difference simulations

Safe Time	NFPA 130 Appendix C (RSET)	FDS Simulation (ASET)	NFPA 130 (ASET)	BuildingExodus simulation results (RSET)	
				Stairs (Default)	Stairs & Escalators (Default)
U2 Evacuation	3’	6’40”	4’	5’14”	4’01”
Total Evacuation	5’45”		6’	43’03”	9’29”



the queue around U2-3-6 stair at 400 second

the queue around U2-4-6 stair at 500 second

Figure 5-1: *U-2 platform level evacuation using buildingEXODUS (total evacuation)*

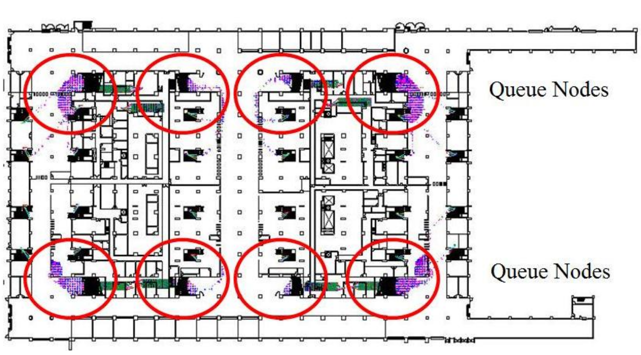


Figure 5-2. *Queue Nodes in U1 Concourse Floor*

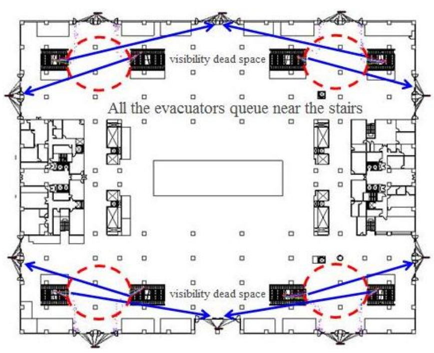


Figure 5-3. *Queue Nodes in G1 Ground Floor*

6. CONCLUSION REMARKS

This study used an extreme but credible arson incident as an example to review the evacuation issues in Taipei Main Station. Obviously the purpose is to show the dilemma of ongoing development or continuous risk in this exist Co-construction. Through this study and field survey, there are evidently some evacuation problems in this existing transportation facility. For example, the available escape routes located in both extreme ends of the 2nd and 3rd platforms, which lead directly to the ground, have always been ignored by evacuees. Inadequate lighting, miscellaneous goods and damaged/defaced signs around emergency stairs impede evacuation and rescue. Even when exits are available, the narrow access routes to emergency stairs and fire doors may also cause queuing, blocking, pushing and collapsing rails. To improve these deficiencies, using the appropriate method and location in each exit, posting warning placards to direct passengers, adopting slopes instead of steps, and setting access control points with surveillance equipment are strongly recommended. In addition, a standard operating procedure for emergency response should be established to cope with different incident situations. For example, the emergency exits are normally closed and manually opened by designated staff once an incident has occurred. Those staff can also guide passengers through available exits to relatively safe places.

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Fire Safety Management System in Modern High-rise Buildings - Hong Kong Perspective

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Wan-Ki Chow [2]

ABSTRACT

The erection of 7627 blocks of high-rise building within the territory of 1092 km^2 makes Hong Kong popular and famous for it's 'Concrete Jungle' in the world. It has long been a question of life safety and property protection in fire situations of these buildings. Bitter experience learnt from the major building fires in the past twelve years together with the result of a territory-wide building survey within the period are discussed in this paper. In addition, the fabulous, complex and innovative building designs using fire engineering approach to meet with these building features are other great challenges to building fire safety. To secure the overall fire safety in these buildings, a total fire safety concept by employment of the fire safety management system, combined use of the hardware (active and passive fire protection systems) and software (building management and knowledge base of the management staffs) and a safety audit system to ensure mitigation to the potential risks posed are also introduced and discussed.

KEYWORDS

High-rise building, fire engineering approach, active and passive fire protection systems, fire safety management system, fire safety audit system

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1. INTRODUCTION

Hong Kong is a Special Administration Region of mainland China. Its territory area is just 1092 km^2 with a population of seven millions. High-rise building is defined in the Code of Practice for Minimum Fire Service Installation as those structures when building height reach thirty metres [FSI 2005]. The development and the trend to build more high-rise buildings is the only solution to the problem. Because of the trend, controlling authorities and building safety professionals raised great concerns on the safety of people staying in these high-rise buildings, in particular we still have such buildings erected in this 'concrete jungle' for more forty year. Not to say the big fires happened in the past twelve years claimed tens of lives and injuries. Despite a number of follow-up actions have been taken by the controlling authorities including the enactment of laws, it appears that the subsequent good fire safety practices might have been deteriorated as reflected in the increased number of fires at institutional buildings and the housing estates which are generally high-rise [FSD 1998-2007]. It is true that new buildings when we first move-in are considered safe but might not be true years after. To keep these buildings in good and safe condition, maintenance and good management to these buildings are solutions for the purpose. To meet with the objective, implementation of the fire safety management system and monitored by a fire safety audit system will greatly secure the overall safety of the buildings.

2. CONCEPT OF FIRE SAFETY IN BUILDINGS

The safety concept is to maintain building fire safety to a reasonably practical standard so as to provide a safe place for the people to live in and protect property in the building. To ensure the purposes can be met, we have to consider the following basic controlling measures:

- Control ignition of materials
  - ignition sources
  - ignitability of the material
  - combustibles

- Control fire spread
  - combustibility
  - fire propagation
  - spread of flame

- Control of fire resistance
  - building materials
  - non-structural material – fixtures

- Control illegal building works
  - removal or addition of building works
  - alteration of building works

- Controlling and enforcing follow-up and subsequent actions in the routine maintenance work are properly carried out especially those required by laws.

The controlling measures mentioned required a systematic and manageable approach to handle. This involves a management team to manage the defined objectives and execute and monitor the measures. However in defining the objectives, the management has to be well conversant with the fire safety concept or in a more generic representation by the total fire safety concept [Chow 2004].

The principle of the concept involves the following stages:

- Identification of risks from the building and building environment;
- Using the passive fire protection and active fire protection systems to mitigate the identified risks;
- Since these protection systems require physical management actions to follow up and will therefore oversee by the fire safety management system.

This concept can be represented by the following figure:

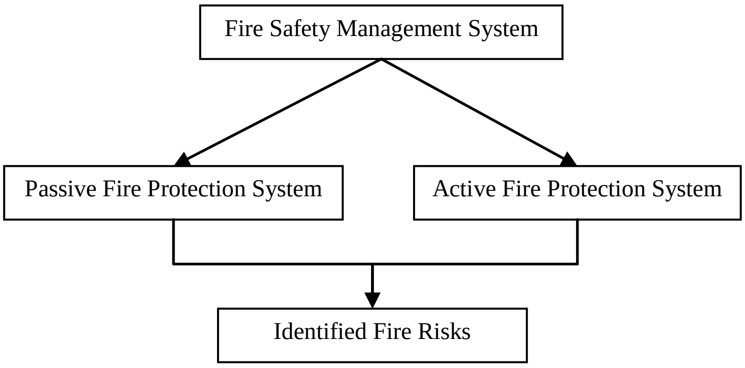

Figure 1*: Total fire safety concept diagram*

3. MAJOR FIRE SAFETY PROBLEMS AND IRREGULARITIES IN EXISTING BUILDINGS

To have a closer look into the issues, I have selected some past major fire incidents and a building survey conducted by Hong Kong Fire Services Department for discussion.

Table 1. Major fires in the past 12 years

Month/Year	*Type of Building*	*Injuries/ Fatalities*	*Major irregularities/problem identified*
Nov./1996	Commercial 15-storey	80/41(*)	• Replacement of metal lift doors by wooden partition during maintenance work in lift lobbies; Unsatisfactory building management
Jan./1997	Commercial 20-storey	13/17	• Non-functioning of the sprinkler system; • Wedged-open of lobby protection doors; Unsatisfactory building management
April/1997	Residential 20-storey	37/9	• Storage of plastic foam containers and commercial commodity; • Wedged-open/defective smoke lobby doors; • Unsatisfactory building management
May/2007	Industrial 23 -storey	6/1(*)	• Sprinkler system failed to work
Aug./2008	Composite 15-storey	55/4(**)	Major irregularities include(#): • Wedged- open lobby protection doors; • Sub-standard smoke lobby door; • Large amount of combustions used in the 'Karaoke Box'

(*) Including one fire fighter
(**) Two fire-fighters
(#) The irregularities were based on the information from the media and my personal judgment. A death inquest will be convened in the coming months.

4. TERRITORY-WIDE BUILDING SURVEY ON FIRE SAFETY [FSD 1998]

Subsequent to the major fire incidents in 1996 and 1997 (Table 1), Fire Services Department conducted a territory-wide fire safety survey with a view to improve the fire safety in the community by analyzing the survey results and formulated a package of administrative and legislative measures. During the survey, a total of 27148 nos. of pre-1987 building were inspected. Survey data collected were analyzed by giving a Fire Safety Index which was composed of Fire Services Installation (FSI) Index on the provision and maintenance of the FSIs and Fire Safety Management (FSM) Index on the condition of the fire safety management in the buildings. The inspection result was summarized in the following diagram and tables.

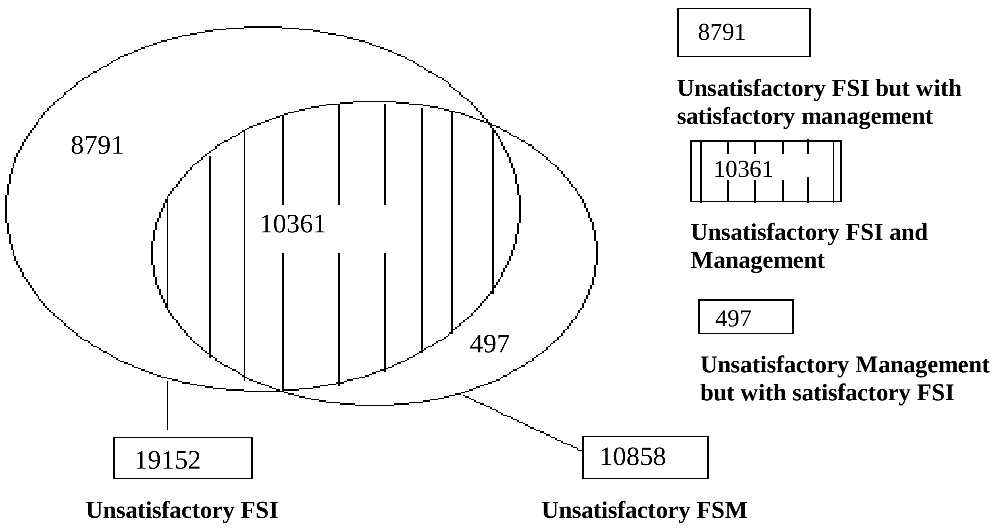

Figure 2: *Diagram showing the distribution on the unsatisfactory surveyed buildings*

Table 2. Buildings required improvement

Buildings requiring rectification of FSI defects	1,984	7%
Buildings requiring upgrading of FSI	19,152	70%
Buildings requiring improvements to fire safety management	10,858	39%
Buildings requiring improvements to both FSI and FSM	10,361	38%

Table 3. Statistics on Fire Hazards Reported by the Survey Team

	Industrial	*Commercial*	*Domestic*	*Institutions*	*Composite*	*Others*	*Total*
Floating obstruction	124	109	215	23	2,091	2	2,564
Locked roof/ground exit	61	88	411	32	1,950	6	2,548
Defective/ Missing smoke stop door	254	116	170	24	1,988	4	2,556
Metal gate erected across means of escape	54	7	156	0	658	0	875
Defective FSI	270	71	228	27	1,381	7	1,984
Total	763	391	1,180	106	8,068	19	10,527
Fire Hazard Abatement Notices issued							1449

From the given details on existing buildings, either from the major fire incidents or the building survey, we can summarize the irregularities into three major categories, i.e. failure in active fire protection systems (e.g. defective sprinkler, detection system etc.), failure in passive fire protection system (e.g. removal of protected lobbies, defective lobby doors etc.) and unsatisfactory fire safety management system (e.g. wedge open of lobby doors, floating obstruction in common area, locked exits etc.) in the buildings.

5. IMPROVEMENT OF THE TOTAL FIRE SAFETY CONCEPT MODEL

Since the early nineties, Buildings Department and Fire Services Departments of Hong Kong accepted the application of the performance-based building designs due to complex nature, innovative, or special building feature of the nowadays buildings provided that the application of fire engineering design as an alternative to the prescriptive provisions providing this approach, have to observe the following fire safety concerns raised by the Director of Fire Services [FSI 2005]:

- The design will not provide inferior safety standard to the prescriptive requirements;
- The methodology for application of the fire engineering approach should outline a structured fire engineering principle(s) to the assessment of total building fire safety effectiveness; and
- To achieve the pre-identified design objective(s) having taken into consideration of the objectives of fire service installations and equipment for the protection of life and property of the people within the buildings and the firefighting personnel in the event of emergency situations.

Buildings Department has included relevant requirements in the building codes on ‘Means of Escape’, ‘Means of Access’ and ‘Fire Resistance’ since 1996 to reflect the necessary equivalent standard in the application of the performance-based design to new buildings [FRC 1996, MOE 1996, MOA 2004].

<u>Fire Safety Management System for high-rise buildings</u>

- Maintenance on existing provisions of fire protection systems
    - Including the annual inspections as required by laws
    - Code-complied designs
    - Performance-based designs
    - others

- Routine inspection on existing provisions
    - Active fire protection system
    - Passive fire protection systems
    - Building fire safety management
    - others

- Staff training
    - Familiarization of the emergency procedure
    - Staff duty and responsibility
    - Appropriate use of first-aid fire fighting equipments

- To be familiarized with the fire protection systems
- General knowledge in fire safety
- Regular fire drills with staff and occupants
- Identification of fire hazards
- others

- Emergency actions
  - Emergency procedure to be followed, including call to the emergency departments, fighting the fire if consider safe
  - Inform and assist the occupants to evacuate immediately
  - Assist the fire fighters in emergency situation
  - others

- Other activities

In view of the new building designs and the known common irregularities in building and building management, it is therefore in need of a new fire safety concept with an audit system to secure the effectiveness in executing/enforcing the fire safety management system. The structure of the new system on total fire safety concept is modified as below:

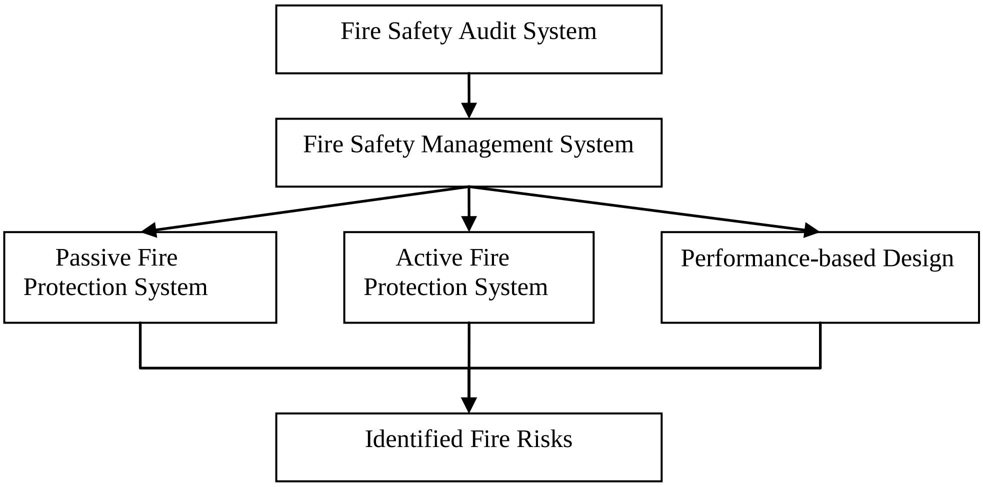

***Figure 3**: Modified Total Fire Safety Concept diagram*

6. THE FIRE SAFETY AUDIT SYSTEM

The audit system is a system used to monitor and ensure the effective operation of the established fire safety management system. It offers a practical way to identify the potential hazards due to inadequate maintenance, inspection on fire service installations and unsatisfactory fire safety management. The priority/weight of the basic event in the fire safety managment system indicates its severity and impact of the event on life safety and property damaged. A team of fire experts, professionals might be required to define/decide the acceptable ranking of each event. Some decision making models such as analytical hierarchy process (AHP), Delphi etc. can be adopted to evaluate the priority according to the judgements from the experts based on variant factors including type of building occupancy, provision of fire service installations, characteristic of occupants etc. To evaluate the inadequacy or deficiency of the fire safety management system, physical inspection or validation test of the sub-system can be used to give the score of each event. The approach provides a quantitative model to evaluate the performance of exsiting fire safety managment system and decide the remedial action to be taken for improvement.

It seems to be a complicated system in achieving the goal because of the involvement of different profesionals in drawing up the decision at the beginning. However, once the decision has been made, it is just a matter of simple calculation with individual inspection result. In fact, there are some tools (computer software) in the market can help. The structure of the audit system is shown as below.

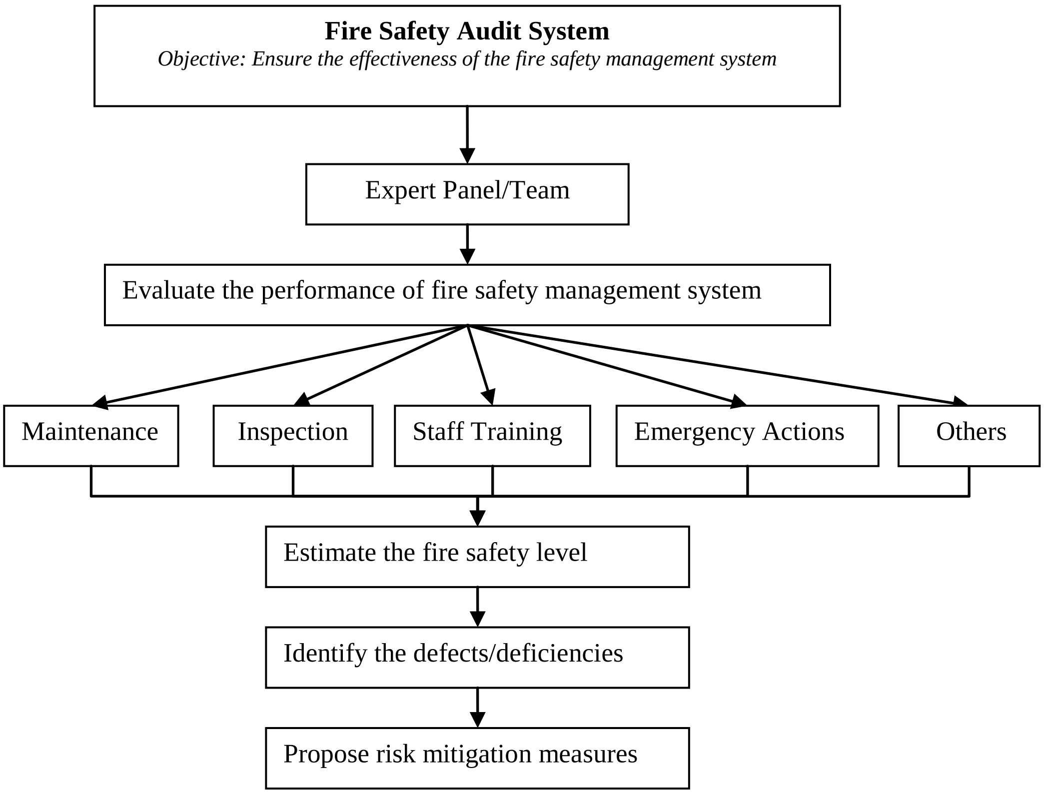

Figure 4: *Diagram of Fire Safety Audit System*

7. THE ANALYTICAL HIERARCHY PROCESS (AHP) [Saaty 2000]

The analytic hierarchy process (AHP) was developed by Professor Thomas L. Saaty in 1970s. The AHP provides a comprehensive framework for structuring a complex system and quantifying its elements. It is best suited for multi-criteria decision-making problems that yield priorities for decision alternatives. The process to establish such a fire safety audit system is briefly described as follows:

- Step 1: Set the fire safety level as the top objective of the fire safety audit system;
- Step 2: Breaking down the system into a hierarchy of decision categories and independent decision elements (attributes);
- Step 3: Seeking expertise advice to make pairwise comparisons of the decision elements and determine the importance and impact of each element on the fire safety level;
- Step 4: Synthesize the comparisons to get the local priorities of the elements with respect to each category/top objective (Local priority);
- Step 5: Determine whether the input data satisfies a “Consistency Test”. If it is not satisfactory, return to Step 3 and repeat the pairwise comparisons process; and

Step 6: Summarize the results to produce the overall priority of each decision elements (Total priority).

After deriving the overall priority of the decision elements, site inspection and validation test can be conducted to evaluate the performance and functions of existing provision of the sub-system as defined in the fire safety audit system. Its performance can be indicated in the numerical score for a given range (i.e. 1~100 indicates the performance/function from worst to best). Finally, the fire safety level of the building can be evaluated as follows:

Fire Safety Level (L)

	Local Priority	Total Priority
1) Maintenance on existing provision of fire prevention system	R_1	
Maintenance on Sprinkler System	k_{11}	$R_1 \cdot k_{11}$
Maintenance on Detection System	k_{12}	$R_1 \cdot k_{12}$
Maintenance on Smoke Extraction System	k_{13}	$R_1 \cdot k_{13}$
Others	k_{1m1}	$R_1 \cdot k_{1m1}$
2) Inspection on existing provision of fire prevention system	R_2	
Inspection on escape route	k_{21}	$R_2 \cdot k_{21}$
Inspection on building layout	k_{22}	$R_2 \cdot k_{22}$
Inspection on building occupants	k_{23}	$R_2 \cdot k_{23}$
Others	k_{2m2}	$R_2 \cdot k_{2m2}$
3) Staff training	R_3	
Staff duty and responsibility	k_{31}	$R_3 \cdot k_{31}$
Appropriate use of fire extinguishing equipments	k_{32}	$R_3 \cdot k_{32}$
Familiar with the fire prevention system	k_{33}	$R_3 \cdot k_{33}$
Others	k_{3m3}	$R_3 \cdot k_{3m3}$
4) Emergency actions	R_4	
Identify the fire hazards and fire causes;	k_{41}	$R_4 \cdot k_{41}$
Inform the occupants to evacuate immediately	k_{42}	$R_4 \cdot k_{42}$
Assist the fire fighters	k_{43}	$R_4 \cdot k_{43}$
Others	k_{4m4}	$R_4 \cdot k_{4m4}$

Fire safety level (L) of the building can be estimated as:

$$L = \sum_{t=1}^{N} \sum_{s=1}^{m_t} R_t k_{ts} x_{ts}$$

Where R_t is the local priority of the t-th category;

k_{ts} is the local priority of the s-th item in the t-th category;

x_{ts} is the score of the s-th item in the t-th category, it is obtained from physical inspections according to check list/s prepared in the fire safety management system;

N is the total number of categories in the fire safety audit system;

m_t is the total number of the items in the t-th category;

8. CONCLUSION

The total fire safety concept allows the building management to exercise their duties and responsibilities in a more systematic and effective manner. The application of an audit system is just another management tool with a view to secure the safety to both people and properties in nowadays complex, innovative, and tall buildings. The success in meeting the ultimate fire safety objectives relies on the joint efforts of the stakeholders, developers, building professionals and the government bodies. Finally, I think we would agree that new buildings with legal occupation permit would be very safe for us to live-in, yet human factors are the main considerations in fulfilling and maintaining the overall safety of the building as well as this fire safety concept.

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A Study of the a-Si PV Module on the Mounting Position and Inclination Angle

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ABSTRACT

The photovoltaic industry of Amorphous Silicon Module begins producing in 2009. The purpose of the study aims a useful mounting position and direction angle for Amorphous Silicon Module. Because the material features of the a-Si PV module, which the absorption spectrum get the effective light trapping between 1.7 eV to 1.8 eV, is different with general silicon based module in architectural use. Thus, the study models face to east and south, which use the DMY (*Daily Mean Yield*) and PR (*Performance Ratio*) to analyze the efficiency on power output at 10 degree and 80 degree. In the whole year efficiency study of amorphous silicon modules, the results showed that the south position is better than east position and the 10 degree elevation is also better than 80 degree. For consideration of each evaluating factor, the better design and mounting direction of high efficiency amorphous silicon modules need to face south direction and have a low angle of elevation.

KEYWORDS

Photovoltaic System; PV, Amorphous Silicon Module; a-Si module , Daily Mean Yield; DMY, Performance Ratio; PR

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1. INTRODUCTION

It is a new age of Taiwan a-Si photovoltaic technology development in 2009. The amorphous silicon (a-Si) module has been produced and sold in the architectural market. The PV module is a kind of agglutination glass plates on building skin material use. The are two types of a-Si PV module, one is general model(glass-to-tedlar) and the other is see-throught model(glass-to-glass)[***Figure 1***][1]. The a-Si PV module has a special feature to transfer the different light-weave to the electrical power, that get the light trapping between 1.7 eV to 1.8 eV [2]. The using field is also different with general silicon based PV module in architectural applications[***Figure 2***]. The mounted direction and position are the important and basical architecture physics to consider the complete integrating with buildings in the high a-Si PV power efficiency.

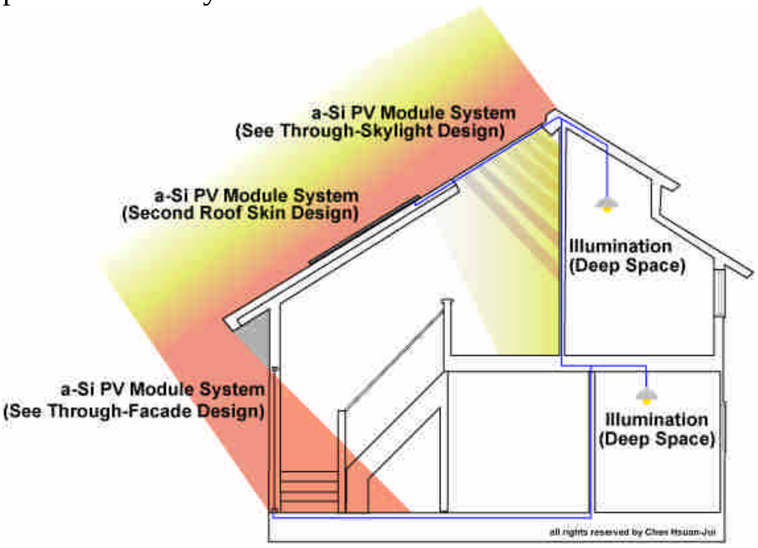

Figure 1: The application of a-Si PV Module (General model & See-through model)

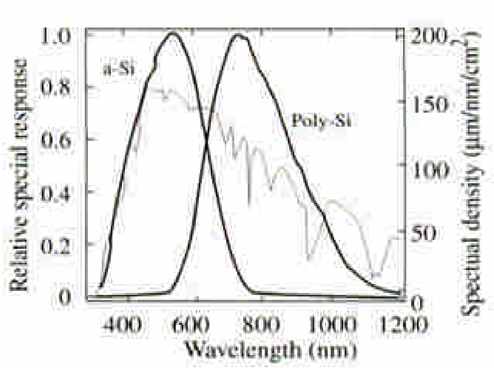

Figure 2: a-Si and Poly-Si absorption spectroscopy

The study will offer a referience data for architectural a-Si PV design in the building. The purpose of this study makes the best use of the a-Si general PV module array system and has a full year power monitored. The study has a reference a-Si PV array in the horizon and two azimuthes, the sourth and the east, where have two a-Si PV modules arraies at the different inclination angle, 10 degree and 80 degree[***Table 1***].

Table 1. The study sample of the a-Si PV Array Test system

Azimuth	Inclination Angle(X°)	System Number
Reference a-Si PV Module Array	0	Group 0
South	10	Group 1
	80	Group 2

East	10	Group 3
	80	Group 4

2. Methodology

2-1 The a-Si PV Module System Discussion

A mounting position and inclination angle study of the a-Si PV module has been doing the whole year research in 2008. The study systems has been installed in the Industrial Technology Research Institute (ITRI), where is the 24°46' North Latitude and 121°02' East Longitude in Taiwan. There were two different azimuthes, 10 degree and 80 degree, were installed at each eastern and southern directions [Table 2].

Table 2. Characteristic parameters of the a-Si PV module system

System Number	*Solar Cell Type*	*Module Rating Power (Wp)*	*System Capacity (Wp)*	*Inverter Rating Power (W)*	*Azimuth Angle*	*Inclination Angle*
Group 1	a-Si	60	1620	1700	Due South	10
Group 2	a-Si	60	1620	1700	Due South	80
Group 3	a-Si	60	1620	1700	Due East	10
Group 4	a-Si	60	1620	1700	Due East	80

2-2 Monitoring Discussion

The factors of the study monitoring included irradiation, temperature (the module's bottom surface) and the power output. The energy measurements were following the test standard of IEC 61724[3]. In order to evaluate system performance, the pyranometer was coincided with ISO 9060 Second Class, which the irradiation data was sampled each time pre- ten seconds and recorded each time pre- minute.

2-3 a-Si PV System Analysis

The DMY(1) and PR(2) are the two main equations to analyze the efficiency on the power output of the research PV systems. The study presented the consistent with monthly irradiation tendency, which the system performance was influenced with the inclinations by sun revolution trajectory.

$$DMY = \frac{E_{out}/day}{P_0} \qquad \text{----------- (1)}$$

$$PR = \frac{E_{out}/P_0}{H_I/G_0} \qquad \text{--------- (2)}$$

E_{out} : system net AC energy output in kWh

P_0 : system rating power in kWp

H_I : total in-plane irradiation in kWh/m²

G_0 : reference irradiance (usually 1kW/m²)

3 Results and Discussion

3-1 The Horizontal and In-plane Irradiation

In the whole year research, the irradiation result reflected south position is better than east position and the 10 degree elevation is also better than 80 degree. The reference irradiation of the horizontal module was 1417.11 kWh/m^2, which compared with the Group 1 inclined relative error was +4.23%, and Group 3 inclined relative error was -1.95%, and Group 2 inclined relative error was -30.38%, and Group 4 inclined relative error was -35.51% [Table 3].

Table 3. Monthly average daily irradiation and annual accumulation irradiation for different azimuth and inclination angle over the monitored period (h)

Azimuth	*Inclination angle*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	***Annual average Monthly daily Irradiation***	***Annual Accumulation Irradiation***
Horizontal	0	2.26	1.69	3.35	3.51	5.15	4.73	5.39	5.54	4.18	4.30	3.13	3.09	**3.87**	**1417.11**
Due south	10	2.49	1.74	3.52	3.55	5.09	4.65	5.34	5.62	4.38	4.73	3.55	3.63	**4.04**	**1477.15**
Due east	10	2.10	1.64	3.27	3.44	5.08	4.74	5.43	5.52	4.09	4.14	3.01	2.95	**3.80**	**1389.54**
Due south	80	2.44	1.31	2.56	2.01	2.22	1.94	2.21	2.89	2.82	4.09	3.60	4.16	**2.70**	**986.46**
Due east	80	1.50	0.99	2.11	2.04	3.11	3.07	3.66	3.75	2.74	2.83	2.26	2.28	**2.54**	**928.13**

The influence of latitude on PV system inclination is self-evident presents. The study used the fraction of total incident irradiation for different irradiance range, which was equal or over 700 W/m^2 of the monitored period. The Group 1 inclined about 42.66%, the Group 3 inclined about 36.10%, the Group 2 inclined about 20.11%, and the Group 4 inclined about 22.78%. According to statistics result, the lower angle system could get the higher irradiation performance than the higher angle system [Figure 3].

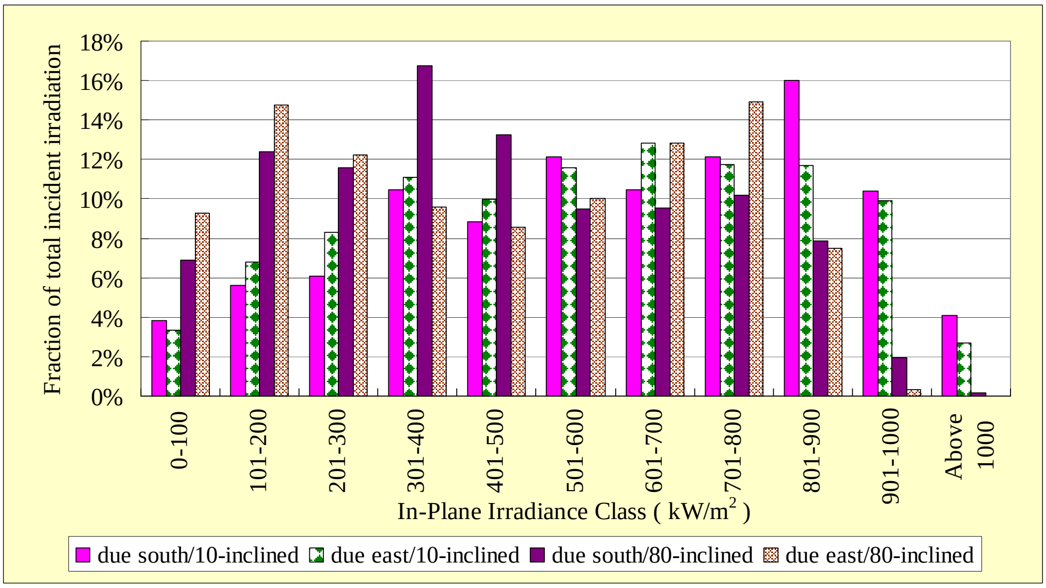

Figure 3: *Fraction of total incident irradiation for different Irradiance range with differentazimuth and inclination angle over the monitored period*

3.2 The PV System Performance Evaluation

3.2.1 The DMY and PR Analysis with Performance Evaluation

The annual DMY and PR showed the different power performance on those four a-Si research systems. The Group 1 had the higher DMY and PR Performance than others, and the Group 4 was the worst in the study. The study showed the DMY data was 3.62 (kWh/day/kWp) at Group 1 system, and the 1.80 (kWh/day/kWp) at the Group 4 and the PR data was 90.53% at

Group 1, and 71.46% at Group 4[Figure 4]. To compare the superior and inferior systems with DMY relative error and PR absolute error were -50.27% and 19.07%. The PR value of high angle systems were worse than low angle systems, then the result also showed the high angle systems had about 28% energy loss by the power transfer from DC to AC[4].

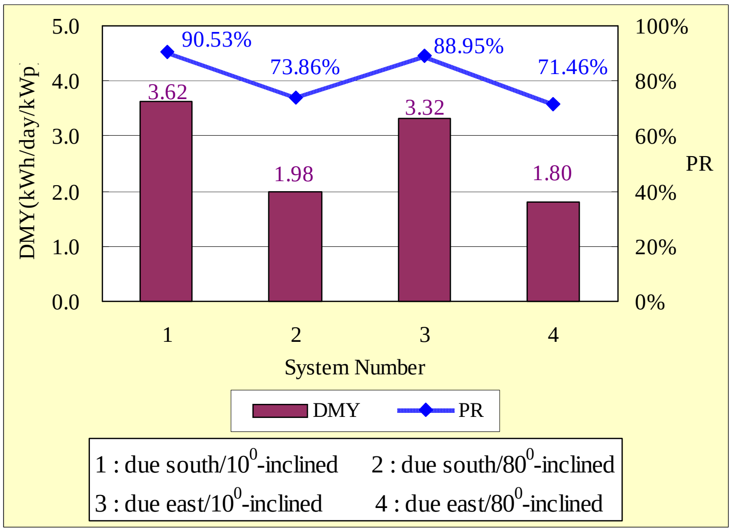

***Figure 4**: Annual DMY and PR of the a-Si system for different azimuth and inclination angle*

The monthly DMY and PR results of the a-Si systems performance were presented almost consistent with monthly irradiation tendency. The two high angle systems performance also were influenced by sun revolution trajectory, consequently the DMY and PR had significant difference between spring/summer and autumn/winter [Figure 5].

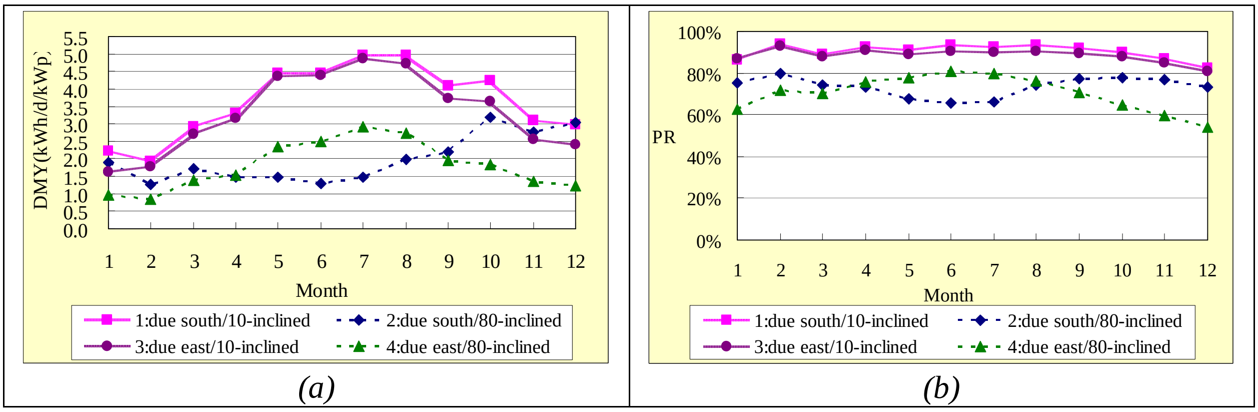

***Figure 5:** Monthly system performance of the a-Si systems in 2008 ：(a) DMY and (b) PR*

3.2.2 The Temperature Analysis with Performance Evaluation

The output power of PV module system has a closed relationship with temperature. The a-Si module system reduce 0.23% power when the temperature increased pre- a degree centigrade[5]. The temperature study field included module and ambient air, which relate with the in-plane irradiance[Figure 6]. In the high irradiance, the Group 1 working system showed the average of PV operating temperatures increased from 7.6℃ to 60.6 ℃ in the ambient air ranged between 9.3℃ and 29.5℃.

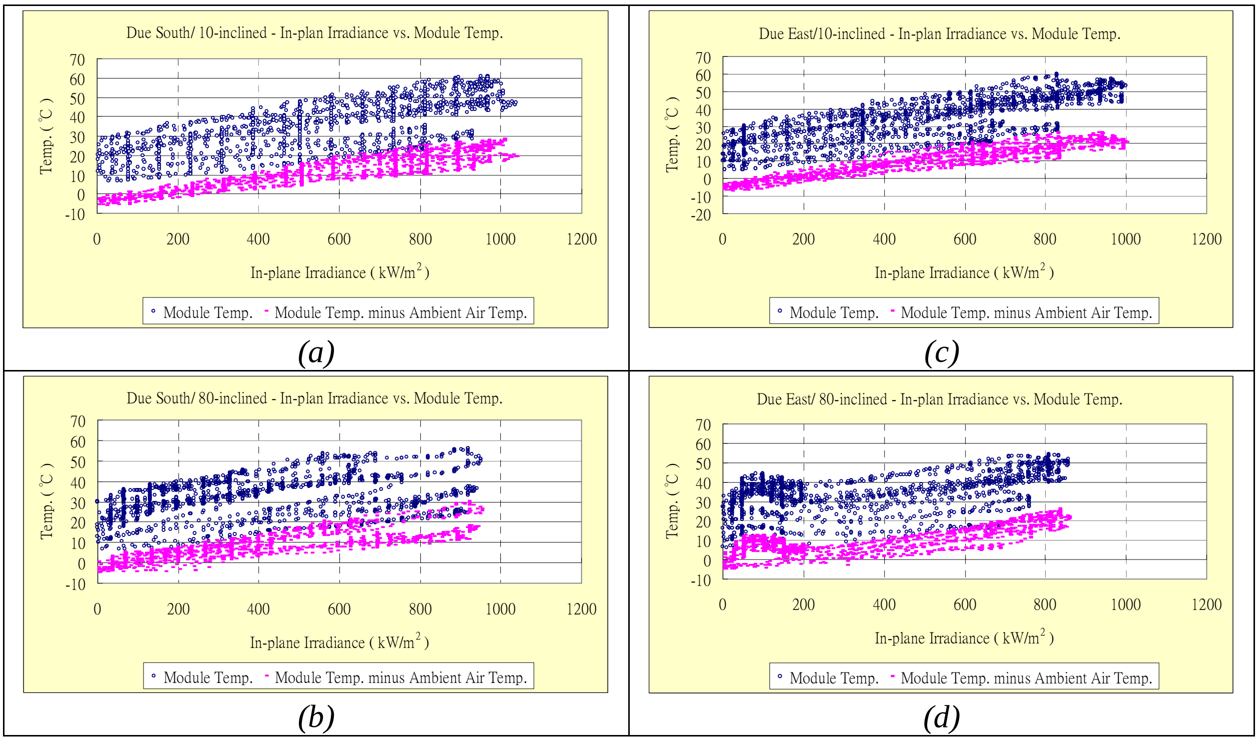

***Figure 6:** ：Temperature difference between PV module and ambient air as a function of in-plane irradiance： (a) due south/10 ^{o}-inclined (b) due south/80 ^{o} -inclined (c) due east/10 ^{o} -inclined(c) due east/80 ^{o} –inclined*

3. Conclusions

The study used the DMY and the PR to analyze the performance of power output by the irradiation and temperature. For consideration of each evaluating factor, the better design and mounting direction of the amorphous silicon modules need to face south direction and have a low angle of elevation. The Group 1 system was superior to other three systems.

[1] The a-Si PV system applied to large angle installation, the inverter could choose Master-slave type or other high efficiency inverter in order that obtain more energy transformation efficiency.
[2] The a-Si module system reduce 0.23% power when the temperature increased pre- a degree centigrade. The latent heat of the a-Si module system could make the building microclimate change and the power loss in the PV working system. The temperature could be responsed by the irradiance changes and variations in wind speed [6]. The thermal-dissipation concept could be considered in the PV system design for enhancing system performance and usability of human life.

4. Acknowledgements

[1] This research was founded by contract 98-D0110 from the Bureau of Energy, Ministry of Economy Affairs.

[2] Photovoltaics Technology Center, Industrial Technology Research institute, the administers for the Division of Photovoltaic Promotion and Advanced Silicon Solar Cell for Taiwan PV project plans.

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Taiwan PV Energy Policy of Conservation Energy and Reduction CO_2 on ITRI's Promotion Projects of Photovoltaic Building

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ABSTRACT

The purpose of Taiwan renewable energy policy is to establish domestic PV power utilization and development, to promote PV technologies and industry, to educate the general public, to conserve energy as well as reduce carbon emissions. Photovoltaic technology transforms sunlight into electrical power, which provides good example for the energy saving and energy generation using solar energy on buildings. However, the dissemination of PV systems in Taiwan has been hesitated by high installation cost. Since year 2000, Taiwanese's government and ITRI have launched several promotion projects for the application of PV on building, such as solar top project, solar city project, the solar village and the solar roof subsidization project. Totally, 5779 kWp PV has been installed in 517 sites (April 1, 2009). Through the successful promotion program, accumulative capacity of 19 MWp will be installed, which can reduce 1,452 tons CO_2 emissions by PV industrial and architectural projects in 2010.

KEYWORDS

Photovoltaic; PV, Solar Top Project, Solar City Project, Solar Village Project, Renewable Energy, Industrial Technology Research institute; ITRI

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1. INTRODUCTION

Following the international concerning of environment concerns, energy issues and reduction of carbon emissions, Taiwan has set up PV promotion policy is in early year 2000, Industrial Technology Research Institute/ Photovoltaic Technology Centre (ITRI/PVTC) had been planning on the PV renewable energy industry and marketing research. The project focuses on the integration of solar energy with building, especially for the subtropical architecture. There are two main installing types on the building construction which are the building integrated photovoltaic (BIPV) and building-add photovoltaic (BAPV). Both of them are well deployed with PV module material in subtropical architecture.

High temperature and high humid environment are the major causes for the building deterioration in Taiwan. To improve the living quality, the building integrated photovoltaic module offers a solution to solve the thermal problem and over-light pollution from sun shine.The characteristics of PV module includes：（1） absorption of sun light for producing electrical power and （2）cooling effect by module shadow for the building skin and interior environment. The power efficiency depends on the solar irradiation , so it is not only reduce the peak loading in noon but also send the redundant power back to the utilization company, Taiwan Power Company (TPC). Through the function of BIPV, PV and energy saving concept can be integrated as good show case for public education purpose.

There are five main PV promotion projects to encourage PV installation system on the building in Taiwan **[1]**.

The Five PV building projects are：

(1) Subsidization Project（Solar Roof Project ）
(2) Solar City Project
(3) Solar Village Project
(4) Solar Top(PV Classic) Project
(5) Remote Islands and Areas Project

Following the Taiwan renewable policy, the PV projects have approved 5779 kWp capacity until April 3, 2009. The total PV capacity will arrive 31MWp on Taiwan renewable policy in 2010. There are three promotion groups, which are ITRI, TPC and residential installation, **(Table 1).** The TPC is planning the PV power plant for large power system. ITRI promotes the PV building projects, which include 19MWp of the total capacity on PV application

Table 1. Taiwan's Photovoltaic Capacity Targets

PV Capacity (MWp)	2006	2008	2010
Bureau of Energy / ITRI	3.4	7	19
TPC	---	---	10
Others	0.1	0.4	1.8
Total	3.5	7.4	30.8

2. Taiwan PV Renewable Policy

The photovoltaic installation targets have been shown in **(Table 2)**. The solar power, had achieved over 1MWp capacity in 2006, and grew up from 1.6 MWp to 7.4 MWp during 2006-2008. The PV renewable policy target will be over31 MWp capacities in 2010.

Table 2. Taiwan's Renewable Energy Policy Targets:

Year	2006		2008		2010	
Renewable Policy	MWp	%	MWp	%	MWp	%
1. Hydro	1,911	5.1	2,085	4.31	2,168	5.7
2. Wind Power	203.7	0.5	761	1.62	980	2.6
3. Solar Power	1.6	0.0	7.4	0.02	31	0.1
4. Geothermal	---		---		---	
5. Biomass	600	1.6	646	1.34	741	1.9
6. Fuel Cell	---		---		---	
7. Ocean Energy	---		---		---	
Total	2,716		3,499		3,910	
Share of Renewable Energy power in the capacity of national electricity generation	7.3%		7.3%		10.3%	

2.1 Conservation Energy and CO_2 Reduction By PV system

Benefits of the PV renewable energy include not only generate electricity but also reduce CO_2 emissions with 0.637 kg/kWh **[2]**. The PV technology, the PV module which includes solar cells, transfers the sun-light into the electric power for citizen use. Following the Taiwan renewable energy policy, the total capacity of PV will arrive 31 MWp, whose target will gain 44,640 MWp power and reduce 28,435 tons CO_2 in 2010.

3 The 31 MWp PV Plan of Bureau of Energy and ITRI Projects in 2010

ITRI and Bureau of Energy will help government policy to research and promote 19 MWp on PV building projects. The projects have been displaying from 2000 until now, and also have the future plans on the PV renewable energy development roadmap. There are five main promotion projects to help renewable policy action in Taiwan. Those projects are the subsidization project, solar city project, solar village project, solar top (PV Classic) project and remote islands and areas project, which the PV installation plans on the legal buildings in Taiwan **[3]**.

3.1 Subsidization Project

The project, the earliest PV promising project, focuses on the general urban house that continues from 2000 until now. There were two different programs on the project. One is the 50% money back and the other was full money back **[4]**. The full money back program was in the beginning promotion, whose purpose was to provide education for the user, who was the first PV group to help ITRI research of PV materials and systems, and the deadline was in the end of 2004. The 50% money back program is for Taiwan citizen who has interesting on the PV renewable energy to install and join the PV renewable policy research on their individual legal buildings. Therefore, there are more and more people who are joining the half price money back program, which is the popular and fresh for general users. Before the deadline of this paper due, there are 428 PV systems which have the total capacity about 4,458 kWp that produce 5,350 MWh, which can reduce 3,317 tons CO_2 in a year (***Figure 1***).

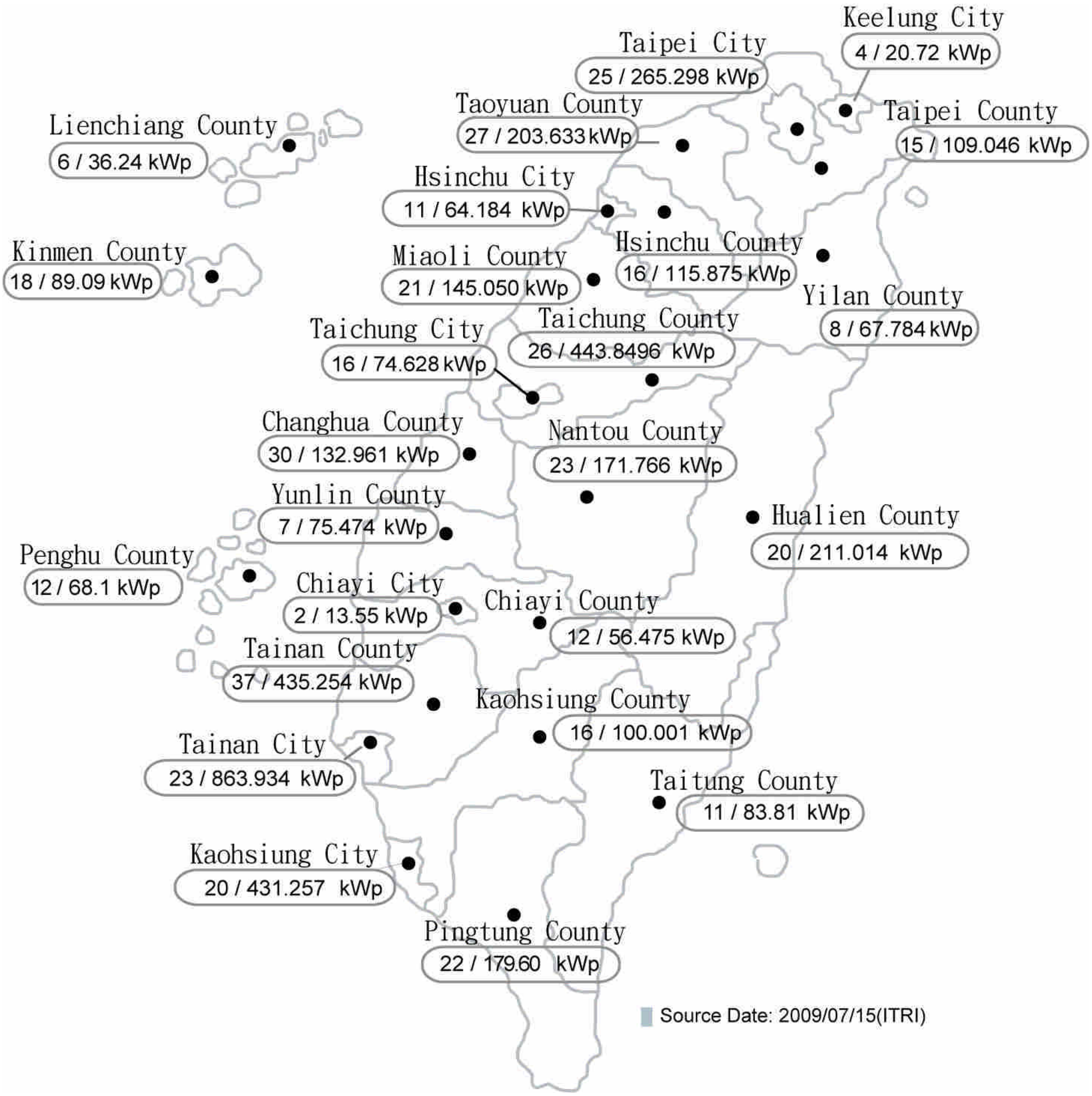

***Figure 1:** The Subsidization Project*

3.2 Solar City Project

The project, the public building project, was the complete architectural and environmental planning for the field. The project's scope were the city type that the project need to have local character, which include the architectural design, space plan, environmental plan and transportation plan. The two local governments, Taipei county and Hualien city, had been chosen to conduct this project (***Table 4***).

Table 4. Solar City Project

Solar City Project	Location	Capacity (kWp)
HweiLan Sport Center	Hualien City	202.4
North Taiwan PV Leisure City	Taipei County	240.16
Total		442.20

3.3 Solar Top(PV Classic) Project

In 2006, the project focused on the well-know landmark building in Taiwan local government, which was a single public building and needed to combine the local culture with environment. There had been chosen four cases, which were in Kaohsiung City, Tainan City, and Pingtung County (***Table 5***).

Table 5. Solar Top(PV Classic) Project

Solar Top(PV Classic) Project	Location	Capacity (kWp)
The Lovely Pier	Kaohsiung City	75
National Museum of Taiwan History	Tainan City	195
National Museum of Marine Biology & Aquarium	Pingtung County	100
Liudai Hakka Cultural Park	Pingtung County	70
Total		440

3.4 The PV Emergency project for Remote Islands and Areas

The project had been begun from 2005 to 2007, which focused on the special remote fields where used PV system to become the emergency equipment for the preparedness against natural calamities, like the wind disaster and the earthquake. There were ninety seven cases in the project, which had 550.55 kWp capacities(***Table 6***).

Table 6. Remote Islands and Areas Projects

PV Emergency project for Remote Islands and Areas	Capacity (kWp)
2005	148.48
2006	137
2007	215.07
Total	500.55

3.5 Solar Village Project

The new PV policy plan, the solar village project, just started in late 2008. The project scope focuses on the congregate housing, which the community building was applied to become a group like the small town which installed and collected each PV module array to be big PV systems for local community residents using. The project would try to build a miniature individual PV power plant in city plan.

4. Conclusions

It is the greatest work to use the renewable energy for saving the energy problem and the greenhouse effect on the earth. The conservation energy and CO_2 reduction are the two main duties of the renewable energy using. The Photovoltaic is the natural and suitable stuffs to be integrated with building in human's life [**5**]. Taiwan is late beginning on the photovoltaic policy research, so the PV promotion programs are still planning which modify with Taiwan citizen. The environmental consciousness becomes stronger and stronger and PV renewable energy using has been accepted little by little in Taiwan Following the government's renewable PV policies plans and projects, the cumulative of PV power shows that PV industry and architectural projects are the well to develop together[***Figure 2***]. The PV module is one kind of high efficiency green material on building use, which can absorb sun light from the face of PV module and make the shadow for internal cooling by the back of PV module. The

PV materials are easy to use the sustainable concept to combine with building and design in human life.

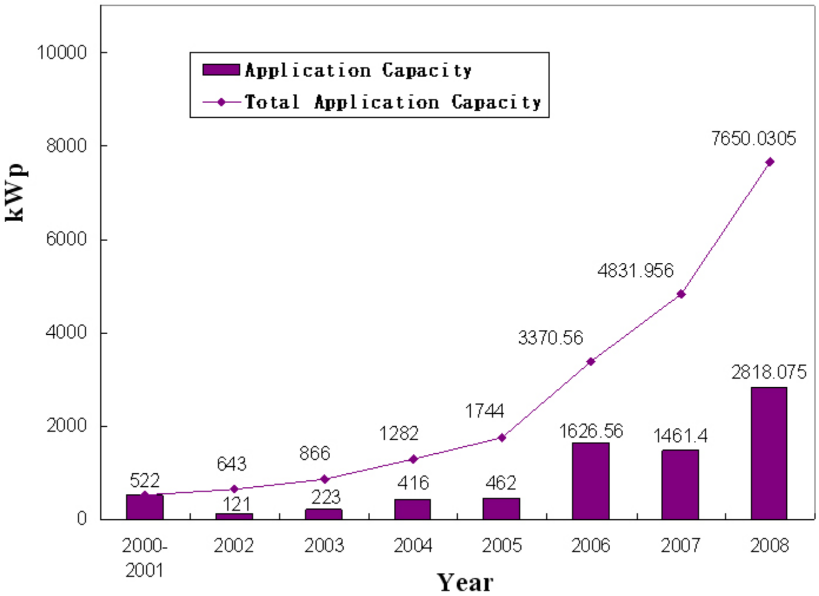

Figure 2: *The Cumulative Applied PV Power in ITRI (2008)*

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[1] The Bureau of Energy, Ministry of Economic Affairs, Government of Taiwan for the granting funds for the PV Projects.

[2] Photovoltaics Technology Center, Industrial Technology Research institute, the administer for the PV renewable energy policy research for Taiwan PV project plans.

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How universal design works on Taiwanese Houses

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ABSTRACT

As we know people in nowadays societies spend more than 90% of their time indoors. Hence, indoor environmental design (IED) has a significant impact on their long-term-life-living. In this article I will utilize the seven principles of Universal Design (UD) to run how universal is universal design regarding to Taiwanese Houses. I will address on the Taiwanese culture and its housing types to see if it is accessible for everyone to live with independent in their recent house; and how universal design works on the Taiwanese housing.

Meanwhile, I will also describe general issues of health harms associated with indoor environmental phenomenon to human beings. As the results, we can figure out what the main policy we should process on the codes of Taiwanese architectural principles to make people live with accessible and affordable to achieve healthier indoor environments.

KEYWORDS

Universal Design, indoor environmental Design (IED), policy recommendations, Architectural Codes, accessible, affordable, independent, barrier-free, a long term living, life cycle，Sustainable Building (SB)，Health Building (HB)

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INTRODUCTION

Most environments seem tailored to people with a standard size and a specific range of mental and neurological abilities. Our contemporary cities are like monstrous cookie cutters shaped to exclude people who cannot function within certain limited physical parameters.

Ken Dychtwald (quoted in Venolia, 1988)

In other words, the physical environment handicaps many and magnifies the disabilities that can, or may, occur during all the various life-cycle states (especially for infants and from aging), from normal healthy conditions (such as pregnancy), from chronic conditions (such as asthma), and from acute or temporary conditions (such as from falls and other so-called “accidents”).

This is the case regarding housing in Taiwan today. There is clear evidence that much, actually most, housing in Taiwan is inadequate for those outside some idea of “normal” adult human performance. In addition, the population of the elderly in Taiwan is increasing both in absolute numbers and as a percentage of the total population. All in all, the main challenge for architects, designers, builders, citizens, and public officials in Taiwan is to comprehend the fit between the existing housing stock and the citizens of Taiwan, and respond if the “ fit “ is found to be inadequate.

Selected characteristics of the Taiwanese population and of housing

The following sections describe selected characteristics of the Taiwanese population and of housing in Taiwan.

Population of Taiwan

The estimated residential population for 2009 in Taiwan Area totals 23,000,000 persons. The average annual growth rate of the population was 0.9% over the past decade. Moreover, the average annual growth rate had continuously declined in the period from the 1996 census to the 2000 census as show in table2-1.

Table 2-2 illustrates the Taiwan population by age group for 1990 and 2000. The United Nations calls an “aging society” that society with a percentage of its population 65 years-and-overs at 7% of the total population. Between 1990 and 2000, Taiwan became an “aging society” by UN definition. Figure 2-1 shows that the shape of Taiwan’s population structure is changing from the classic “pyramid” to that of a “column”. This occurs as the sign of younger age cohorts decrease and members of older age cohorts survive longer.

2-1Table Average annual population growth rates for selected historical censuses

Average annual population growth rates for selected historical censuses

	Grand total person	Average annual growth rate %
Census 1966	13,505,463	3.7
Census 1970	14,769,725	2.3
Census 1975	16,279,356	2.0
Census 1980	18,029,798	2.1
Census 1990	20,393,628	1.2
Census 2000	22,300,929	0.9

Resource: The Ministry of Interior Department

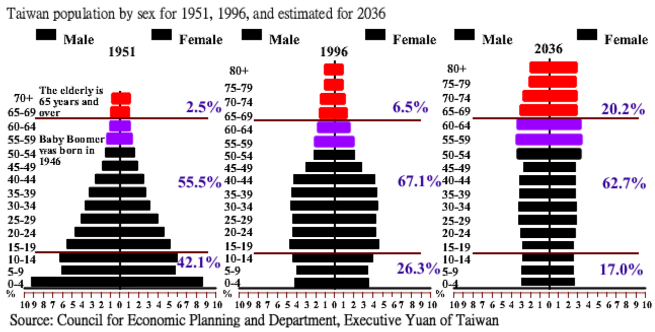


Figure2-1 Taiwan population by sex for 1951, 1996, and estimated for 2036

An estimate of the aging population by the Ministry of Interior Department suggests that the total aging population will increase each year between 2000 and 2010 on average 47,000 persons. The aging population will rise to 9.8% of the total. From 2010 to 2025, the 65-and-over population will increase each year to 124,000 people to become 16.5% of the total population in 2025. That percentage will expect to jump to 20% of the total population by the year 2032. These estimates suggest that over the next 20 years, the older population category will increase by more than 13%. Perhaps the most important trend in aging population statistic affecting the demand for universal design is that of the aging of the so-called Baby Boom generation, the dramatic population increase in Taiwan and elsewhere that began in 1946. Today, 2009, many members of that generation are now in their 50s.

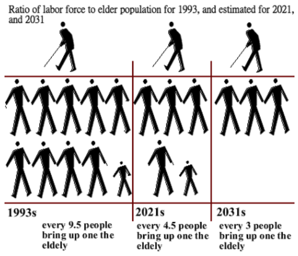


Figure2-2 Ratio of labor to elder population for 1993, and estimated for 2021, and 2031
Source: Council for Economic Planning and Department, Executive Yuan of Taiwan

2-3Table Comparison of percent 65-and-over of population by selected countries

Comparison of percent 65-and-over of population by selected countries

Country / Years	Sweden	United Kingdom	France	Germany	United States	Japan	Singapore	Taiwan
1900	8.4	5.2	8.2	---	4.1	---	---	---
1960	11.8	11.7	11.6	10.8	9.2	5.7	---	2.5
1973	14.5	13.6	13.2	13.9	1. 10.5	7.9	2. 5.7	3.2
1984	16.9	14.8	12.9	14.7	3. 11.7	10.0	4. 7.2	4.8
2000	17.2	15.3	14.7	16.7	12.0	15.1	11.1	8.4

1. - 1975 2. - 1970 3. - 1985 4. - 1980

Source: 1. Council for Economic Planning and Development, Executive Yuan of Taiwan
2. Singapore Census
3. Johnson, P., etc, (ed.), Workers vs. Pensioners: Intergenerational Justice in an Aging World, Manchester U. Press, 1989, p. 26-27.

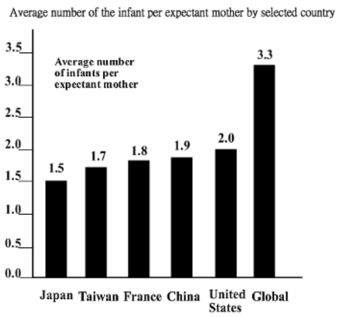
2-4Table Comparison of the total years of the aging population's ratio from 7%-14% and over in different country:

Name of Country	Ratio of aging population 7%	Ratio of aging population 14% and over	Total years of the aging ratio from 7%-14% and over
Taiwan	1994	2021	27years
Singapore	1980	15% 2010	30years
Japan	1970	1994	24years
United States	1945	2015	70years
United Kingdom	1930	14. 8% 1984	54years
Germany	1930	14. 7% 1984	54years
Sweden	1890	14. 5% 1973	83years
France	1865	14. 7% 2000	135years

Source: 1. Population Census, the Ministry of Interior Department of Taiwan
2. Singapore and Japanese Census
3. Johnson, P., etc, (ed.), Workers vs. Pensioners: Intergenerational Justice in an Aging World, Manchester U. Press, 1989, p. 26-27.

Singapore, Japan, and Taiwan became "aging societies" later than other countries, but in contrast to the Western countries listed they have taken (or will take) fewer years to reach the doubling of the UN definition (from 7 to 14 percent of the population 65-and-over).
The Taiwanese Ministry of the Interior Department's Department, population statistics show that in 1993, there were 9.5 people, -less-than-65 for every person 65-and-over. Their estimate for 2021 suggests there will be every 4.5 people for each 65-and-over person. By 2031, their estimate is that the ratio will be 3:1. (See Figure 2-2)
A related population issue is that of birthrates. As shown in table 2-5, the birthrate in Japan is the lowest of these selected countries. However, the birthrate of Taiwan ranked second.

2-5Table Average number of the infant per expectant mother by selected country



Source: Population statistics of the Ministry of Interior Department of Taiwan

Housing Stock/Housing Types

The development of the Taiwanese housing stock and housing types reflects economic development. For example in the year 2000, the percentage of those employed in the service sector is almost 8 times that of agriculture. This is a radical shift from what was the agriculture/industry/services employment split in the early 1950s. At that time, the agricultural sector amounted to 64 percent of all employment. Big cities and metropolitan areas gained housing as a reflection of this shift in economic development. Housing architecture shifted as well. “Typical” housing types shifted from low-density to high-density; the housing types changed from the traditional rural house (type A) to apartments and high-rise building. The new units are smaller than traditional house and, by many accounts; the living quality is inferior to the earlier town house < tou-tian-cuo >. (See figure 2-3&2-4, and table 2-6&2-7)

The popular or typical housing units from 1940s to 1990s can be divided into seven types. Type A is the Traditional rural house. Type B is the Semi-detached house. Type C is the Terraced house< a two or three story house is so-called tou-tian-cuo >. Type D is the Five-and-fewer story apartment buildings without elevators. Type E1 is a unit found in buildings of 6 to 12 stories. Type E2 is a unit found in buildings that are over 12 stories high. Type F is the residual category “others”. (See figure 2-3&2-4, and table 2-6&2-7)

Figure 2-3 and Table 2-6 illustrate the shifts in the types of housing between 1980 and 1990. This shift continued the changes that began as the result of economic development and political changes in Taiwan since the 1940s. For example, there were no apartment structures (types D, E, and F) prior to 1960. The longer-term changes are illustrated in Figure 2-4 and Table 2-7 showing the total housing units built by type and by decade since the 1940s compared with the totals in existence prior to 1945.

2-6Table Taiwan households by housing type and percent for 1980 and 1990

Taiwan housholds by housing type and percent for 1980 and 1990

Household / Housing Types	1990s		1980s	
	Household	%	Household	%
A	664,233	13.14	874,519	23.78
B	560,890	11.10	455,477	12.39
C	2,020,820	39.99	1,478,053	40.19
D	1,432,367	28.34	745,841	20.28
E	343,902	6.80	78,992	2.15
F	31,691	0.63	44,418	1.21
Total	5,053,903	100	3,677,300	100

Source: Population statistics of the Ministry of Interior Department of Taiwan

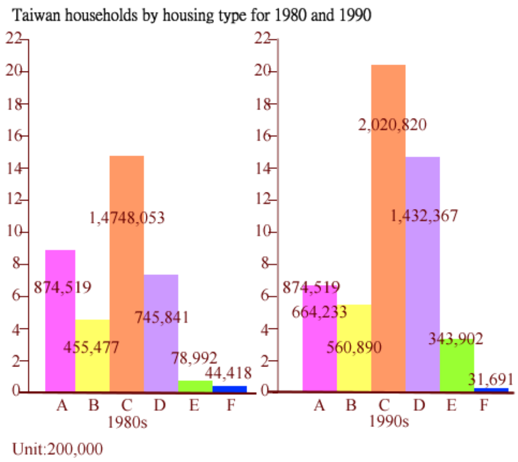


Figure 2-3 *Taiwan households by housing type for 1980 and 1990*

Source: Population statistics of the Ministry of Interior Department of Taiwan

Economic characteristics of housing
In terms of percentage, relatively few people 55 and over are low-income. Moreover, those on the leading age of the Baby Boom generation often have substantial income and are inclined to spend it. Perhaps the most important trend in aging affecting the demand for universal design is the aging of the Baby Boom generation, that began in 1946 and that many are just now in their 50s.

Economic Development of Taiwan:

- *Per capita income: 1965 – 203 USD 1980 – 2155 USD 1990 – 7332 USD*
- *But, 1980s and 1990s were big years*
  Example: the housing price of Taipei City
    - *1979: Price increased by 38%.*
    - *1980: Price increased by 47%.*
    - *1989: Price increased by 96%.*
    - *1990: Price began to drop.*

Summary & Conclusions
Aesthetic vision and fantasy form/type are important elements in the cultural well-being of a society. However, concerns for human physical abilities, for livability across the whole life cycle, and the responsiveness of the environment to human needs are also vital elements in good architecture and a health for environment.
Critics note that the architecture profession recently has failed to respond and to respect the needs of all people, especially with regarding to aging and the recognition of physical abilities outside some narrow range of what is normal. Furthermore, because architectural and environment of regulations and codes are not clear in directing and organizing designs that respect all people, it is often difficult to create environments that are both equitable and accessible. The seven principles of Universal Design provide "guideline" for design that improves the quality of our living environment by being accessible and fit all people.

Rationale for this topic
According to the Taiwanese 2009 census, the population of the elderly increased from 7%to 9.7% over the previous Census in 1994; in other words, Taiwan has become an "aging society" by the United Nations' definition.
As shown in chapter 2, the birthrate in Taiwan ranks second only to Japan in being the lowest birthrate of industrialized countries. The higher number and percentage in the population of so-called Baby Boomers adds further to the emerging challenge of adequately serving the people of Taiwan. It is obvious to me that the built environment and architecture should be accessible and equitable to fit all needs of human with time.
My reading of Taiwanese literature suggests to me that UD is not well understood in Taiwan. Since I believe that a wide-ranging educational effort will be necessary to introduce UD properly in Taiwan, we need to begin now with the training and retraining necessary to create accessible and equitable places to live for all people in the coming decades. Therefore, I would like to utilize the principles of UD to improve the housing in Taiwan.

Rationale: Why is UD important in design, including Architecture, Physical environments, Products, Equipment?
UD is an approach to design not only for creating barrier-free environments, but also for design for a wide-range of people. While it has aimed at making spaces accessible, equitable,

and adjustable to individuals with physical handicaps, its real goal is to improve access for all users to make life easier and safer, and equitable.

UD in Taiwanese housing:

From my analysis and evaluation utilizing the seven principles of UD of Taiwanese housing, and its related economics and culture, I found that there are many issues presented in the existing housing stock.

A summary of issues for each housing type follows:

Housing Type A: (Traditional rural house)

The toilet is often located outside the living quarters; connecting the toilet room main space or building is desirable. By changing the traditional spherical door knob to a lever-type hold-able doorknob would improve access and control for many users. Reducing the traditional high thresholds and steps perhaps by adding a ramp to the steps or both sides of the threshold would make room access more accessible, safe, and convenient.

Housing Type B: (Duplex House)

Here too, provisions for overcoming steps, change-in-floor-levels, and high thresholds would improve room access, safety, and convenience.

Housing Type C: (Terrence House)

The lack of a bedroom and restroom on the first floor makes this housing type less attractive and convenient for many lifecycle stages. It is necessary to reconsider building a bedroom and restroom for people with disabilities and physical change with aging, sometimes meanwhile, a stair lift or household elevator may make upper floors accessible. People often utilize an iron grille or gate in the entrance to prevent the thieves. Because the iron grille is heavy, it is not easy to open, even with health people. Therefore, there is a value in utilizing other materials in doors in maintaining security while not making the door and grill a barrier for household members.

Housing Type D: (Apartment- less than five storeys)

In the housing type D, there is no elevator provided in the building. People with disabilities or having physical problems, find it difficult to traverse stairs. A lift is or elevator would greatly improve access.

Housing Type E: (Raise housing- more than five storeys)

Most kitchens in Taiwanese housing including type A to E are small and narrow, especially in housing type D and E. My analysis at kitchen and cooking tasks in such place suggests that solving these problems will be difficult.

Is Universal Design universal in Taiwanese Housing?

The earlier chapters introduce the seven principles of UD as a guideline for design. However, when the principles of UD are applied to Taiwanese housing, I have found that all principles are not completely utilized as appropriate to all housing types. Different cultures, religions, living styles, as well as living customs, give rise to different environment-design traditions. These traditions may be contrary to the underlying lease of guidelines conceived in a country with other traditions. In this case, the principles of Universal Design may be in conflict with the principles of "Feng-Shui". Feng-Shui is an important consideration issue to most persons in Taiwan, especially to the elderly and current adults. For example, in 100 percent of the housing type A, there is a high threshold or doorsill in front of building. (See figure 5-1) This architectural feature, believed by some to have originated as a response to heavy rain flooding, and typhoons, is reinforced by Feng-Shui. That is, people should raise a foot to go into the inside building. Its threshold presents the meanings of respecting the ancestors of household, a means of warding off evil spirits, and, still, protection from the rainwater flowing into the house. The high threshold makes access difficult for some people, especially

for kids, the elderly, and people with disabilities. However, it is a main point of design to consider "living custom" in Taiwanese housing, such as bathroom it is also found high threshold to prohibit the water flowing out from the bathroom. Further, Taiwanese take showers on the floor in bathroom, not in shower stalls or tubs. In addition, because the drain plumbing is above the general floor-level, the bathroom floor-level is higher than neighboring room (See figure 5-2).
The principles of UD are design-guidelines; but when all principles are applied to Taiwanese housing, they may not all be appropriated within the housing-design tradition of Taiwan. The influence of Feng-Shui is one such instance. Therefore, principles of UD are not completely universal in all Taiwanese housing, especially considering the influence of Feng-Shui on living customs. However, I believe applying that the seven principles did identify problems inherent in Taiwanese housing. Applying some principles of UD will improve the design-quality of Taiwanese housing, as I indicated in chapter 4. The seven principles of UD also assist designers, architects, and builders to consider accessible and adjustable designs for all people in serving a wider-range of population needs and in limiting undesired accidents.

Problem Statement

This is the case regarding housing in Taiwan today. There is clear evidence that much, actually most, housing in Taiwan is inadequate for those outside some idea of "normal" adult human performance. In addition, the population of the elderly in Taiwan is increasing both in absolute numbers and as a percentage of the total population. All in all, the main challenge for architects, designers, builders, citizens, and public officials in Taiwan is to comprehend the fit between the existing housing stock and the citizens of Taiwan, and respond if the " fit " is found to be inadequate.

Review of Literature

UD Definitions & Principles

In 1987, Ron Mace coined the term, "Universal Design". Although Mace, an architect and wheelchair user, died in June 1998, the concept continues to develop and grow in importance. Thus, UD began in the field of architecture and has expended into unless thole, other areas, such as a quote use this list produce design, environmental design, and assistance technology.

UD, also known as "design for all' accommodates and considers the range of environmental design for humans of all ages, sizes, and abilities. It is especially concerned with people with what others call "disabilities" and those dependent upon assistance occasionally or at a single point in time in their efforts to otherwise be independent.

Its principles are usually codified in seven categories; additional memory aids have been developed to explain and reinforce the principles.

Principles of Universal Design

Principle 1: Equitable Use- the designs can be of equitable use to every one.
Principle 2: Flexibility in Use- the designs are base on the needs of people.
Principle 3: Simple and Intuitive Use- Every one can be simple in use with intuition.
Principle 4: Perceptible Information
Principle 5: Tolerance for Error- [the designs must allow users to make a mistake without something dangerous occurring.]
Principle 6: Low Physical Effort
Principle 7: Size and Space for Approach and Use

Research of Methodology
Description of and examples Taiwanese housing types and utilize the 7-principles to make solution on those hosing to provide an affordable, suitable and comfortable living places for beings.

Results: A re-design of Type C housing in Taiwan
Utilize UD to redesign and remodel an existing example of Type C housing in Taiwan.

Considering principles of UD, the following issues emerge
There are no bedrooms and bathrooms on the first, or ground, floor. Therefore, people with disabilities or with loss of mobility (e.g. as may be experienced in aging), who often have difficulty going up and down stairs, have limited choices and may spend much time isolated on an a bedroom floor level or on the first floor without a proper bedroom. Few storage places are found in typical Taiwanese housing, especially, in this case no storage units or closets are found in the house. Therefore, people will pile goods, boxes, or the like on the top of the cabinets, tables, or any place around house. Because many pre-1970 housing type C units often originated as single-story houses and now has grown to as many as three and half stories. The space arrangements and the stairs make this type inconvenient and unsafe for kids, the elderly, and people with disabilities. As the seven principles of UD have been used to redesign and remodel the housing making this housing type accessible and adjustable using for people within a variety of conditions.

Summary & Conclusions
Aesthetic vision and fantasy form/type are important elements in the cultural well-being of a society. However, concerns for human physical abilities, for livability across the whole life cycle, and the responsiveness of the environment to human needs are also vital elements in good architecture and a health for environment.

Critics note that the architecture profession recently has failed to respond and to respect the needs of all people, especially with regarding to aging and the recognition of physical abilities outside some narrow range of what is normal. Furthermore, because architectural and environment of regulations and codes are not clear in directing and organizing designs that respect all people, it is often difficult to create environments that are both equitable and accessible. The seven principles of Universal Design provide "guideline" for design that improves the quality of our living environment by being accessible and fit all people.

Rationale for this topic
According to the Taiwanese 2000 census, the population of the elderly increased from 7%to 8.3% over the previous Census in 1994; in other words, Taiwan has become an "aging society" by the United Nations' definition. In addition, comparison of the aging populations in different countries shows that although both Sweden and France became aging societies early in 1890s and 1865s respectively, the total years for the aging ratio to increase from 7% to 14% (and over) had increased slowly over 83 years and 135 years. In contrast, Singapore, Japan, and Taiwan not only became an aging society later than numerous other countries, but they took fewer years to double the aging population ratio. (Table 11)
As shown in pre-description, the birthrate in Taiwan ranks second only to Japan in being the lowest birthrate of industrialized countries. The higher number and percentage in the population of so-called Baby Boomers adds further to the emerging challenge of adequately serving the people of Taiwan. It is obvious to me that the built environment and architecture should be accessible and equitable to fit all needs of human with time. My reading of

Taiwanese literature suggests to me that UD is not well understood in Taiwan. Since I believe that a wide-ranging educational effort will be necessary to introduce UD properly in Taiwan, we need to begin now with the training and retraining necessary to create accessible and equitable places to live for all people in the coming decades. Therefore, I would like to utilize the principles of UD to improve the housing in Taiwan.

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Influence of fire source locations on the actuation of wet-type sprinklers in an office fire

Ko-Jen Chen [1]
Chun-Ta Tzeng [2]
Chi-ming Lai [3]

Abstract

An experiment is conducted on a full-scale model office space and an actual sprinkler system to explore the influence of fire source locations on sprinkler actuation. The investigated fire source locations include the room center, wall center, three special locations at the room corners, and other locations at different distances from sprinklers. The office space is a brick structure with dimensions of 5 x 6 m and with a net room height of 2.4 m, and contains four installed sprinklers. The fire source is a 100 kW LPG burner. The results show that actuation of the sprinklers is affected by the fire source locations and the heat conduction of the glass temperature sensing ball. Actuation is more rapid if the fire source is closer to corners or walls.

Keywords

fire, office, sprinkler, fire source

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1. Introduction

At a fire scene, the phase change of water from liquid to steam effectively removes heat directly from flames, slows high temperature combustion, and cools the fuel surface directly via the latent heat of evaporation. Large amounts of steam can also reduce the oxygen concentration (particularly effective in enclosed areas) to extinguish fire [1]. Such characteristics make water a preferred extinguishing agent. Inside buildings, automatic sprinklers deliver water drops in the fire protection area to restrain, control, and extinguish fires. When heat or smoke initiates the detection component of the sprinkler system, the system pressurizes water into the activated sprinklers to extinguish the fire. Wet type sprinkler systems are highly recommended since they have a simple structure, low maintenance cost, high reliability, and fast response. Regarding the spatial characteristics affecting sprinkler actuation, the study of fire extinguishment performance of sprinklers in buildings with an atrium is becoming more important as such spaces become more commonplace. Given this, recent literature on the actuation of sprinklers has mainly focused on cases with an atrium [2]. In this study, an experiment is conducted on a full-scale model office space and an actual sprinkler system to explore the influence of fire source locations on sprinkler actuation.

2. Research Method

2.1 10 MW Fire Test Facility

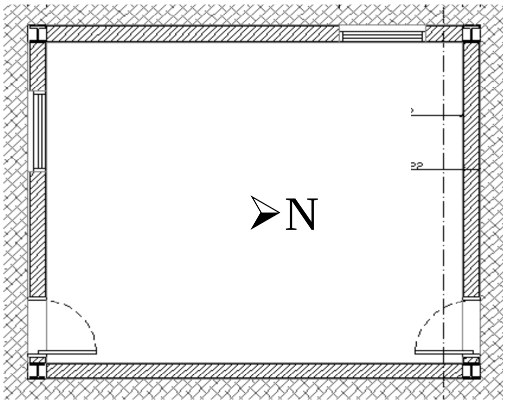
A full-scale fire experiment was done using the 10 MW fire test facility and a combustion gas continuous online analysis system. The device is in the Fire Experiment Center, Architecture & Building Research Institute, Ministry of Interior, located on the Gueiren Campus of National Cheng-Kung University. The combustion gas continuous online analysis system consists of (1) the gas analysis system (including O_2, CO, CO_2, NO_X, and HC analyzers, as well as a gas sampling/calibration system), (2) an optical density analyzer, (3) a flow rate/temperature monitor, and (4) a data processing system. The 10 MW fire test facility consists of a smoke collection hood, smoke collection bend, mixture tube, measurement section, exhaust bend, and exhaust pipe, as in Fig. 1 and Fig. 2. Large objects or structures can be placed on the floated platform under the hood❶ for testing. Hot gas, smoke, and combustion products are collected with the smoke collection hood, flow vertically through the smoke collection bend❷, are transferred horizontally into the mixture tube❸, go through the measurement section, and exit through the exhaust bend❹ and exhaust pipe❺. The end of the exhaust pipe is finally connected to a waste gas treatment system❻. A large exhaust fan in the waste gas treatment system offers a maximum 30 m^3/s fire gas flow.

Fig. 1 *∶10 MW fire test facility*

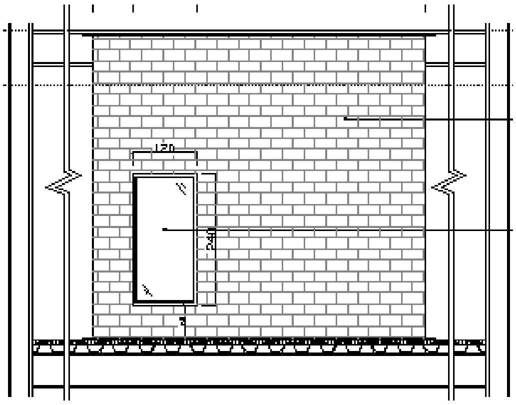
Fig. 2 *∶Waste gas treatment system*

2.2 Investigated Model Office

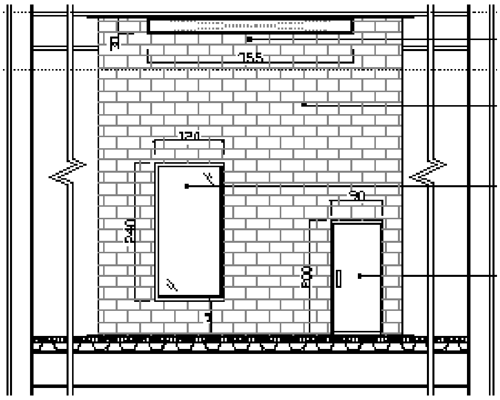
The investigated model office, as shown in Fig. 3, is located below the smoke collection hood of the 10 MW fire test facility. The plane dimension is 6 m ×5 m (wall core line); the net ceiling height is 3.3 m; the walls are brick-laid in 0.26 m thickness using reinforced bricks. Both northeast and southeast wings have a 2.1 m × 0.9 m single door to be opened or closed, respectively. The ceiling is made of a light rigid frame and gypsum board. To better directly observe restraint of the fire via sprinkler actuation and water droplets, two 2.4 m × 1.2 m fireproof windows are placed at the north wing of the western wall and the east wing of the southern wall. The distance between the window and ground is 0.6 m.



(a) Plane view



(b) West Elevation



(c) South Elevation

(d) 3D View

Fig. 3 *: Schematic diagram of the investigated model office (not in scale)*

2.3 Sprinkler System

Under domestic regulations, the number of sprinklers is based on the effective protection area of each sprinkler. The protection diameter of the sprinklers used here is 2.3 m, meaning the maximum protection area is 10.56 m^2; the number of sprinklers is 5 × 6/10.56 = 3. Considering the appearance in actual design, one can have (r=2.3 m, $S=\sqrt{2}\,r=3.25$ m = sprinkler pitch) length: 6/3.25 = 2 sprinklers and width: 5/3.25 = 2 sprinklers. Four sprinklers are installed uniformly in the model room and placed 15 cm below the ceiling, as shown in Fig. 4. The end of each sprinkler pipe is connected to a pressure gauge, and quick joints report independent pressure observations and the stuffing of the water source. The sprinkler's K-factor is 80 LPM/(bar)$^{1/2}$, its temperature rating is 68°C, its response time index (RTI) is 131.54 (m s)$^{1/2}$, and its C-factor is 0.647 (m/s)$^{1/2}$.

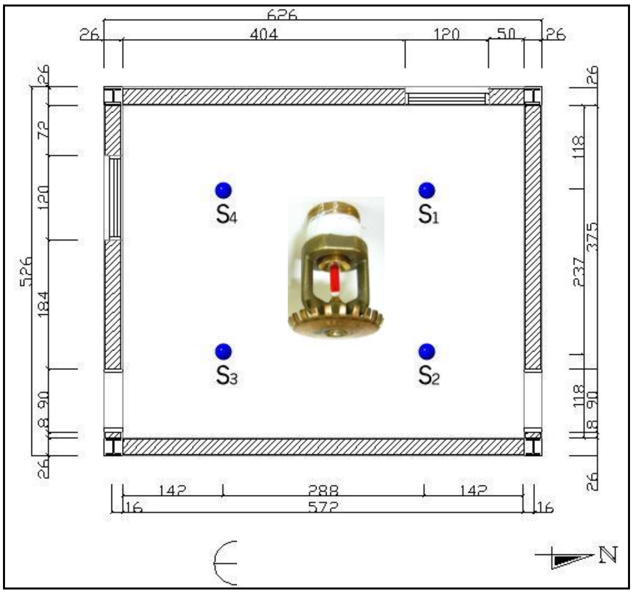


Fig. 4 *：Sprinkler layout*

2.4 Experimental planning

The fire source used in the experiment is a 100 KW rectangular propane burner with dimensions 18 cm × 18 cm. Various fire source locations, including the room's corners, walls, and center, are selected for an office fire scenario, as shown in Fig. 5. To understand the effect of the walls on the spread of the fire, the centers of the walls serve as fire source locations, numbered W1-W3. To understand the corner effect, the northwest corner serves as a fire source location, and is numbered C1. The fire source location at the room center is numbered M1. Other locations, numbered X1-X3, Y1-Y2, and Z1-Z2, are selected on symmetrical lines and diagonal lines. Because of symmetry, the experiment focuses on the right side (north wing). Fig. 6 shows the office interior.

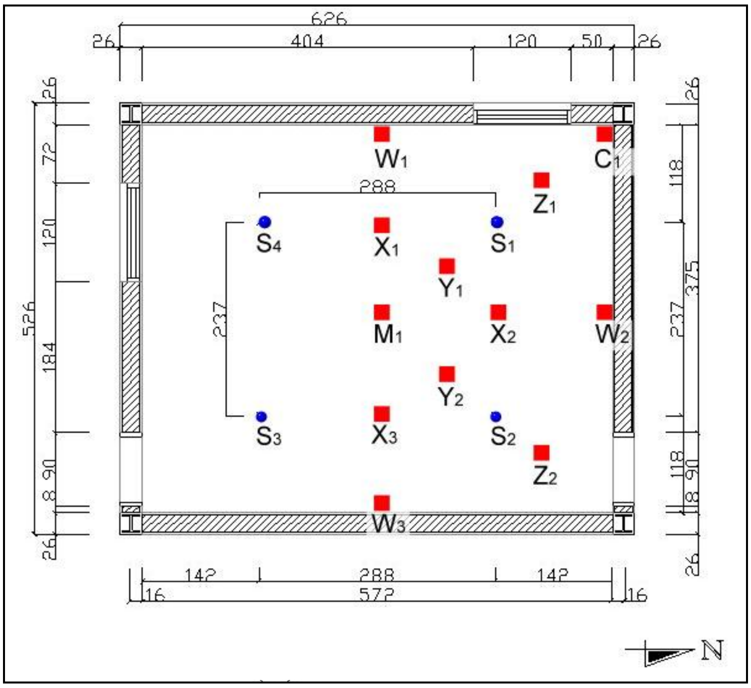


Fig. 5 ***：Interior layout of the full-scale office fire experiment***

Fig. 6 ***： Interior layout photo through southeast opening***

3. Results and Discussion

3.1 Fire source at the center

As shown in the temperature data in Table 1 and curve LPG-M_1-W in the top left of Fig. 7, sprinkler S_4 is the first to be actuated at the center fire case, at 142 seconds. It is shown that, due to the flow pattern, cooler ambient air is introduced from the northern door, flows around sprinklers S_2 and S_3, and then flows out of the southern door. Sprinklers S_1 and S_4 show slightly higher temperatures than S_2 and S_3 and thus can be actuated more quickly.

Table 1 Experiment results

Number	*Location of burner*	*Activated sprinkler*	*Sprinkler actuation time* (sec)	*gas temperature* (°C)
LPG-M_1-W	M_1	S_4	142	102.7
LPG-W_1-W	W_1	S_4	97	102.7
LPG-W_2-W	W_2	S_2	91	99.0
LPG-W_3-W	W_3	S_3	109	104.3
LPG-C_1-W	C_1	S_1	75	106.9
LPG-X_1-W	X_1	S_4	141	102.7
LPG-X_2-W	X_2	S_1	123	104.8
LPG-X_3-W	X_3	S_4	130	99.6
LPG-Y_1-W	Y_1	S_1	61	83.4
LPG-Y_2-W	Y_2	S_2	96	102.7
LPG-Z_1-W	Z_1	S_1	73	99.0
LPG-Z_2-W	Z_2	S_2	92	83.7

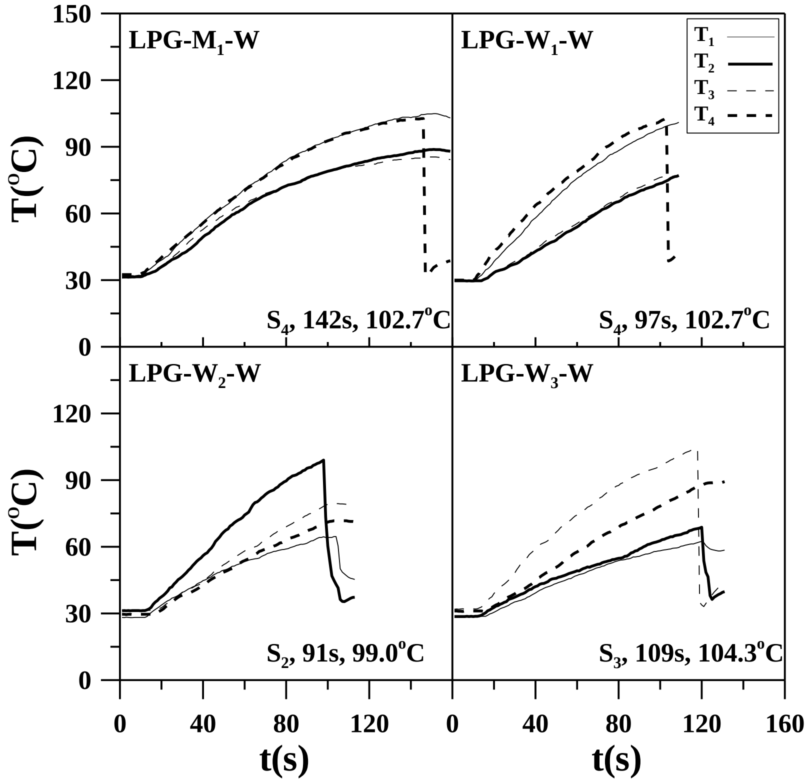


***Fig. 7**：Temperature around the sprinklers with fire sources at the room center and near the walls*

3.2 Fire source close to the wall

Temperature curves of the wall fire cases are shown on the top right, bottom left, and bottom right in Fig. 7. Due to the effect of the wall, flames here are higher than those located farther from the wall. When the fire source is located at W_1, smoke quickly accumulates in the upper level, and a strong hot plume is able to actuate the nearest sprinklers, S_1 and S_4. Sprinklers S_2 and S_3 are actuated when the fire source is located at W_2 and W_3, respectively. The thermal plume from fire location W_2 flows upwards to the ceiling and turns towards the southern door, passing near and actuating sprinkler S_2. Cases LPG-W_1-W and LPG-W_3-W illustrate the same situation. Therefore, both the distance and the flow pattern need to be considered in the actuation of a sprinkler for such a condition. The average actuation time of the sprinklers is approximately 100 sec, which is 40 sec quicker than if the fire source is located at the room center M_1.

3.3 Fire source at corner

The top left figures in Fig. 8 show the temperature curves. The hot plume coming from the fire in the corner is quite concentrated and rises quickly. After reaching the ceiling, the hot gas spreads and dissipates toward the southern door. At 75 sec, sprinkler S_1 is activated.

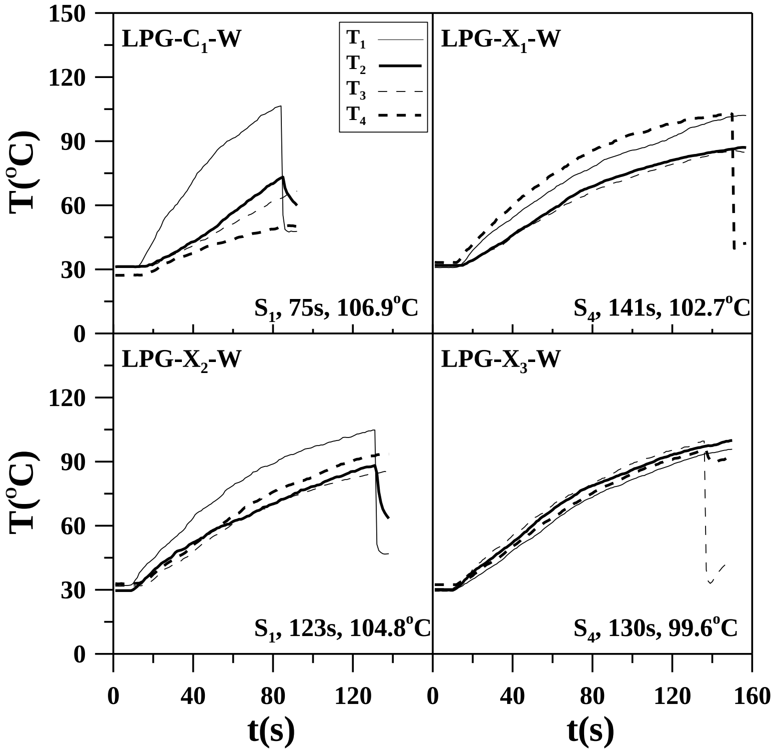


Fig. 8 *：Temperature curves around the sprinklers with fire sources at the corner and other locations*

4. Conclusion

This study explores the influence of different fire source locations on the actuation of sprinklers in an office fire. Twelve fire source locations were tested, including the room center, the wall center, corners, and other locations with different distances to the sprinklers. The findings show that the actuation time of the sprinklers is affected by the fire source locations and heat conduction of the glass bulb of sprinklers. When the fire source is closer to the sprinklers, corners, or walls, the actuation time of the sprinklers is shorter. Because of the wall effect, hot gas is more likely to be induced to flow upwards, and accumulation of upper level smoke is quicker. Average actuation time is 100 sec, around 40 sec faster than if the fire source is located in the room center. For fire sources in corners, sprinklers are quickly activated at 75 sec, showing concentrated hot gas flow.

Acknowledgements

Support from the Architecture and Building Research Institute, Ministry of Interior, Taiwan is gratefully acknowledged.

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Considering SB environmental assessment tool for the performance of buildings in Taiwan

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ABSTRACT

The International Organization for Standardization officially issued ISO 21930 and ISO 15686 standards in 2006, for quantitatively measuring the influence of buildings on environmental performance. SBTOOL is an international assessment tool promoted by the iiSBE, which can be employed to reflect the influence of the different phases of the life cycle of a building on climate, society and economy.

Taiwan has been actively implementing the Sustainable Development Policy, and the Architecture and Building Research Institute of Ministry of The Interior has established the "Green Building Evaluation and Labelling System" in 1999 to promote the so-called Green Building. This research takes SBTOOL which is a prevailing sustainable building assessment tool adopted all over the world as the subject of research and carries out a comprehensive analysis on the development trend of international sustainable building..

KEYWORDS

SBTOOL; EEWH; Performance of Building

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1. INTRODUCTION

The promotion and development of sustainable building have been carried out for several years, and extensively discussed and communicated at as Sustainable Building Conference 2008(SB08) by research teams from all over the world. For building environment assessment tool's conversion in recent years, a trend is forming and intensifying from the use of green building assessment tools towards the development of sustainable building assessment tools.
It is SBTOOL that first developed from GBTOOL into a sustainable building assessment system. At the Sustainable Building Conference 2008(SB08) in Melbourne, SBTOOL was chosen by research teams from many countries as their research subject, whether in terms of regional assessment system development or in empirical comparison between cases.According the relevant studies and literature, and taking the speciality of environmental and climate conditions of Taiwan District, this paper chooses Sustainable Building assessment tool SBTOOL developed by International Initiative for Sustainable Built Environment(iiSBE) and Green Building Evaluation and Label System (TAIWAN EEWH) as objects of comparison Further, cases are used to demonstrate the analysis of differences between these two systems, in the hope of exploring the emphasis or aspects to which attention shall be paid by Sustainable Building assessment in Taiwan District.

2. BACKGROUND

2.1 .International assessment of SBTOOL

SBTOOL into 3-level assessment system comprising assessment groups, which, besides integrating environmental, social and economic aspects, considers Cultural and Perceptual Aspects as well as life cycle of buildings.

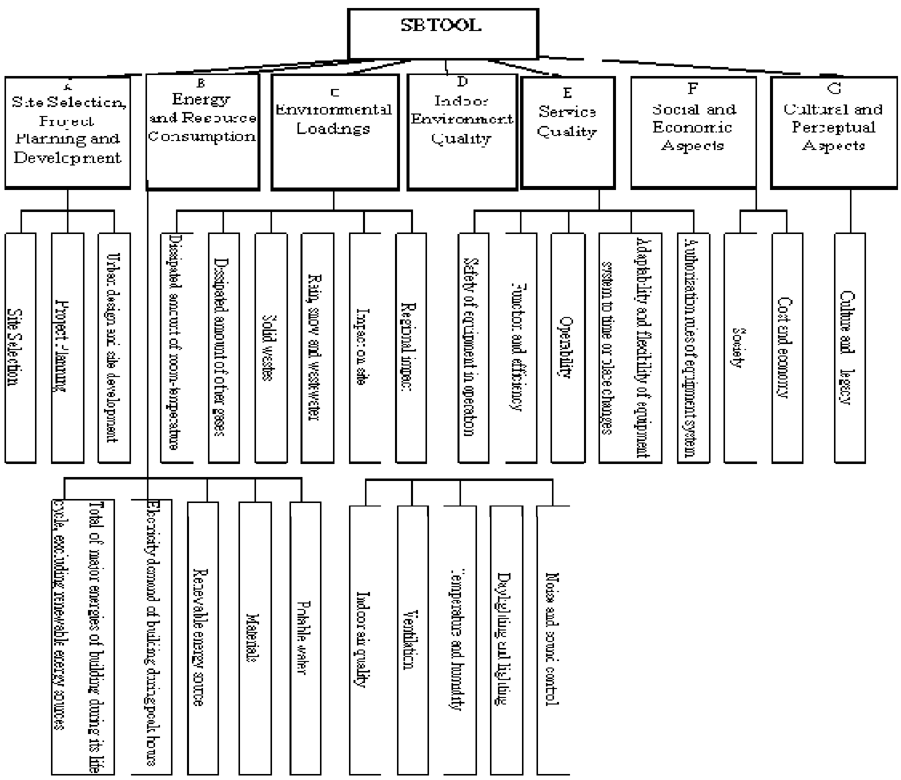

Figure 1: *BASIC ASSESSMENT GROUPS IN SBTOOL.*

2.2 TAIWAN EEWH

To get a full knowledge of the environmental performance and quality of buildings in Taiwan, the Taiwan Architecture and Building Research Institute (ABRI), Ministry of the Interior developed a Green Building Evaluation (EEWH) in 1999 and added two more indicators in 2003. Now there are nine indicators in EEWH for green building assessment: biodiversity, greenery, soil water content, daily energy saving, CO2 emission reduction, waste reduction, indoor environment, water resource, and sewage and garbage improvement. Each assessment item is scored using its respective assessing formula as well as its weight coefficient, and scores are rated into the following ranks: qualified rank(12<=RS<26) bronze rank(26<=RS<34), silver rank(34<=RS<42), gold rank(42<=RS<53)and diamond rank(53<=RS). According to statistics released by the Chinese Architecture & Building Centre (CABC), among new buildings built up during the period from 2004 to 2008, 223 cases have acquired Green Building Labels, and 1072 cases have gained Candidate Green Building certificates. The distribution of green buildings among building types is shown in the chart below.

Table 1. The connection in Taiwan EEWH system and global environment.[ABRI ,2007]

Indicator Category	Indicator	Connection with global environment					
		Climate	Water	Soil	Organisms	Energy	Materials
Ecology	Biodiversity	*	*	*	*		
	Greenery	*	*	*	*		
	Soil Water Content	*	*	*	*		
Energy saving	Daily Energy Saving	*				*	
Waste reduction	CO2 Emission Reduction			*		*	*
	Waste Reduction			*			*
Health	Indoor Environment			*			*
	Water Resource	*	*				
	Sewage & Garbage Improvement		*		*		*

Located in a subtropical zone, Taiwan as a whole has a high-temperature and high-humidity climate. Taiwan is a long and narrow island along north-south direction with the Tropic of Cancer at 23.5 degrees north latitude passing through it. See map below. The climate in the area north to the Tropic of Cancer is subtropical, and that in south is more tropical and warm. Therefore, Taiwan plays an indicative role in terms of environment. In Taiwan's present residential building environment, existing buildings account for 97% and new buildings only 3%. Urban areas are narrow and densely populated, without large hinterlands for use, so the buildings there develop towards high-rise/high density forms whereas, buildings in countryside towns or mountain areas are of low density, without limitations of space. The goal of sustainable development is more easily reached in countryside towns and mountain areas.

All newly built 3 residential buildings cases chosen in this paper are located in Kaohsiung, Taiwan, which, due to being south to the Tropic of Cancer geographically, has an annual mean atmospheric temperature of about 25.1℃ slightly higher than the annual mean atmospheric temperature of the whole Taiwan 24.5℃ and a lowest temperature seldom lower than 10℃ This area experiences the highest temperature in Augusts with the average temperature of 29.6℃ has an annual precipitation of 1720.2mm and an annual mean total sunlight of 2075.4 hours.

3. ANAYSIS AND CASE STUDIES
3.1 ASSESSMENT RESULTS IN TAIWAN EEWH

The results cases assessed by using Taiwan Green Building assessment indicators are all certified, and the scores of individual indicators are outlined in Table 2. The choosing of Taiwan Green Building assessment items is voluntary, so the scores of some items are not blank. However, the biodiversity indicator must be assessed for buildings with site areas larger than 1 hectare. The cases chosen in this study are all residential buildings, so it is unnecessary to assess this indicator. In the cases chosen in this study, the assessment items chosen most among Taiwan Green Building assessment indicators are Greenery, Soil Water Content, Daily Energy Saving, and Water Resource.

Table 2. The assessment results of three residential building-cases in Taiwan EEWH system.

Indicator category	Indicator Name	Case 1	Case 2	Case 3
Ecology	Biodiversity	Free from assessment		
	Greenery	5.8	2.9	2.6
	Soil Water Content	2.3	2.2	2
Energy Saving	Daily Energy Saving	4.2	5.3	11.9
Waste Reduction	CO2 Emission Reduction			
	Waste Reduction			3.3
Health	Indoor Environment		2.1	
	Water Resource	1.7	7.5	2.5
	Sewage & Garbage Improvement	2		2.6
Total score		**21.6**	**20.2**	**24.9**

3.2 ASSESSMENT RESULTS IN SBTOOL

Assessment results gained by applying default weighting values in SBTOOL are indicated in Table 3. In SBTOOL, the first three assessment items having largest default weighting values are Environmental Loadings, Indoor Environment Quality, and Energy and Resource Consumption. In three chosen cases, the first three assessment items having highest scores are Social and Economic Aspects, Energy and Resource Consumption, and Indoor Environment Quality in sequence. If the order of items is considered by using values internally decided by SBTOOL international experts, the item whose Taiwan Green Building score varies from case to case is Social and Economic Aspects.

Table 3. The assessment results of three residential building-cases in SBTOOL system which are adapted the SBTOOL default weighting.

SBTOOL assessment items	weighting value	Case 1	Case 2	Case 3
Site Selection, Project Planning and Development	7.8%	1.8	1.8	1.7
Energy and Resource Consumption	21.6%	2.2	1.7	2.2
Environmental Loadings	25.9%	1.9	1.4	1.9
Indoor Environment Quality	21.6%	1.2	1.9	2.1
Service Quality	15.5%	0.3	0.8	0.4
Social and Economic Aspects	5.2%	2	2.3	2.4
Cultural and Perceptual Aspects	2.6%	1	1	1
self-assessment score		**1.3**	**1.6**	**1.7**

4. COMPARISION

4.1 Comparison of Case scores on SBTOOL and EEWH

In three cases located at Taiwan, viewing from the total score of various items and Taiwan EEWH assessment rating result obtained by entering different weighting values into Taiwan EEWH, the total score computed by using SBTOOL system is closer to assessment rating result obtained by means of Taiwan EEWH after regional experts' opinions have been introduced. Further, if different weighting values are brought into the system, it can be concluded from comparing scores of assessment items that the item whose score varies largely from case to case is "Indoor Environment Quality": the score of this items after the opinions of experts from Taiwan South regarding the weighting values differs largely from case to case.

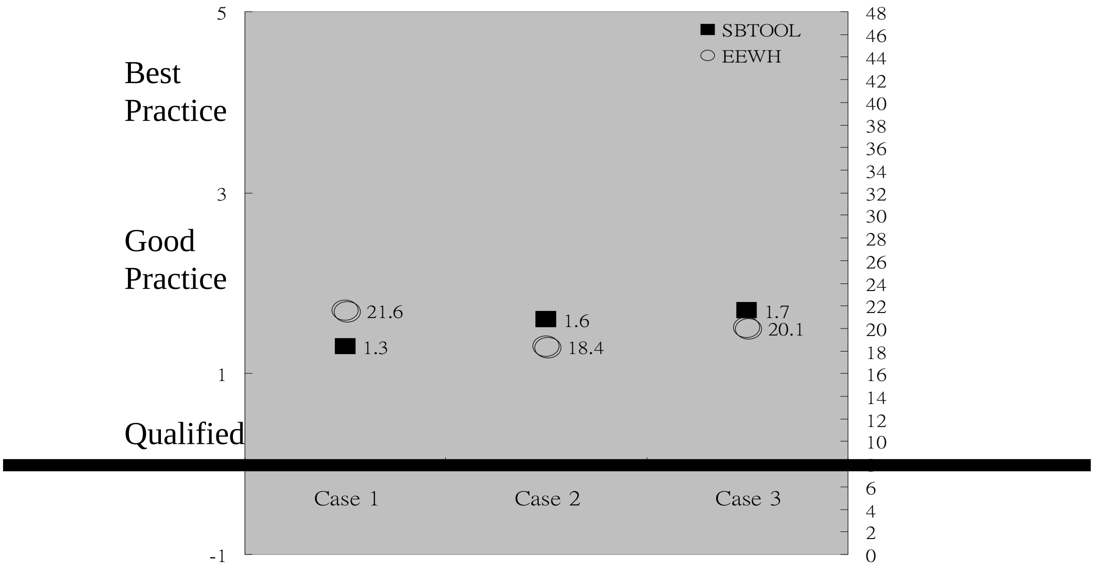

Figure 2: CLASSIFICATION ON SBTOOL DEFAULT WEIGHTING AND EEWH.

4.2 Comparison of Case differences

Assessed by means of SBTOOL, 3 cases are examined regarding such design as follows:

Case1 has three composite functions: the floor immediately under the ground is underground parking space, the floor immediately above the ground is occupied by stores, and the floors above the first floor are used as residence. For the assessment item "Indoor Environment Quality" of the second floor, consuming that the waste of the underground parking space has been removed and the ventilation of stores in the first floor is considered being separated from the main usable space, its score obtained by inputting relevant information into the system is low; in "ventilation" item, the score of each use just reaches the benchmark (equal to 0); In the terms of "noise and sound control" item, the score of such item of the underground packing space doesn't meet the benchmark.

5. CONCLUSIONS

The comparison between the performance results of the cases in the research and those in the previous research reveals that although the scores obtained using SBTOOL and Taiwan EEWH are different, the calculated results were subjected to the correction using regional expert weights.

The establishment of regional Sustainable Building experience doesn't only depend on the existing Green Building techical indicators. To accommodate the causes of variation of each regional condition caused by global climate change, higher benchmark value must be pursued, while the overall performance of buildings is kept unchanged within their life cycles.

The maintenance of indoor environmental quality of a building has a huge impact upon the life of persons living in it. It is found in the exploration of Green Building cases in Taiwan South by means of SBTOOL that the comfort and health of the user in different spaces can be catered for only after different usable areas and environmental conditions have been considered in benchmark for buildings of composite functions.

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Fire Experimental in an Office with Partial Failure of Sprinkler System

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Chun-Ta Tzeng [2]
Ta-Hui Lin [3]

Abstract

In this work, an actual office fire extinguishment by a partially failed sprinkler system was investigated. As per regulations, there were four sprinklers in this model office. In the research conducted here, the first three sprinklers were actuated without water supply, while the last sprinkler was supplied with water at the required operating pressure for a period of 30 minutes. The fire source, a burning plastic trash can filled with 0.5 kg of paper, burned the adjacent chair, desk, desktop computer, and then reached the interior wooden furniture. The results show that the single remaining sprinkler effectively controlled the fire spread for 30 minutes. It does not completely extinguish the fire, but extends the available time for evacuation. Despite this, continuous sprinkling is important because once the water supply runs out, the fire will spread quickly.

Keywords

fire, office, sprinkler

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1. Introduction

At a fire scene, the phase change of water from liquid to steam effectively removes heat directly from flames, slows high temperature combustion, and cools the fuel surface directly via the latent heat of evaporation. Large amounts of steam can also reduce the oxygen concentration (particularly effective in enclosed areas) to extinguish fire [1]. Such characteristics make water a preferred extinguishing agent.

Inside buildings, automatic sprinklers deliver water drops in the fire protection area to restrain, control, and extinguish fires. When heat or smoke initiates the detection component of the sprinkler system, the system pressurizes water into the activated sprinklers to extinguish the fire. Wet type sprinkler systems are highly recommended since they have a simple structure, low maintenance cost, high reliability, and fast response.

Regarding the spatial characteristics affecting sprinkler actuation, the study of fire extinguishment performance of sprinklers in buildings with an atrium is becoming more important as such spaces become more commonplace. Given this, recent literature on the actuation of sprinklers has mainly focused on cases with an atrium [2-4], but there are relatively few studies on the failure of sprinklers in office fire scenes. This study focuses on an actual office fire extinguishment by a partially failed sprinkler system. We observe the actual fire spread using a 3D fire source in the hopes of understanding whether a single functioning sprinkler still controls the fire spread when the others have failed to actuate.

2. Research Method

2.1 10 MW Fire Test Facility

A full-scale fire experiment was done using the 10 MW fire test facility and a combustion gas continuous online analysis system. The device is in the Fire Experiment Center, Architecture & Building Research Institute, Ministry of Interior, located on the Gueiren Campus of National Cheng-Kung University. The 10 MW fire test facility consists of a smoke collection hood, smoke collection bend, mixture tube, measurement section, exhaust bend, and exhaust pipe, as in Fig. 1 and Fig. 2. The combustion gas continuous online analysis system consists of (1) the gas analysis system (including O_2, CO, CO_2, NO_X, and HC analyzers, as well as a gas sampling/calibration system), (2) an optical density analyzer, (3) a flow rate/temperature monitor, and (4) a data processing system.

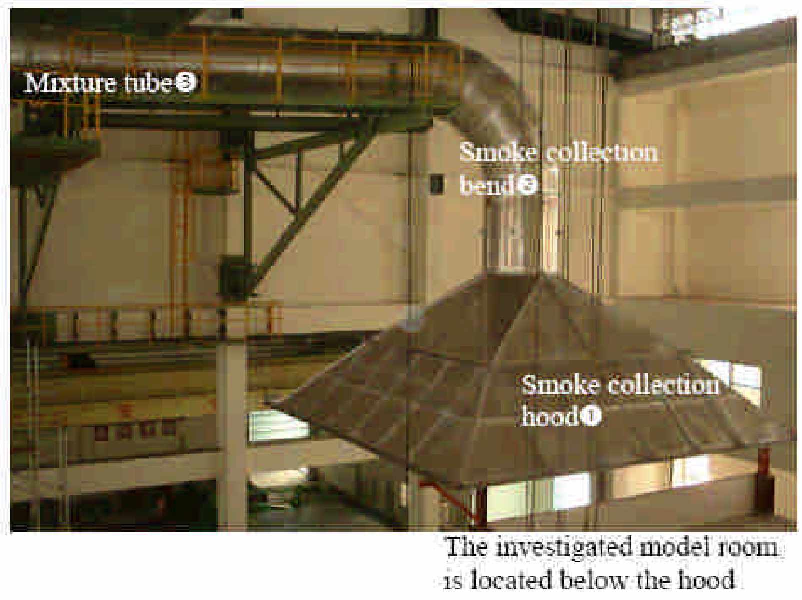


***Fig. 1**：10 MW fire test facility*

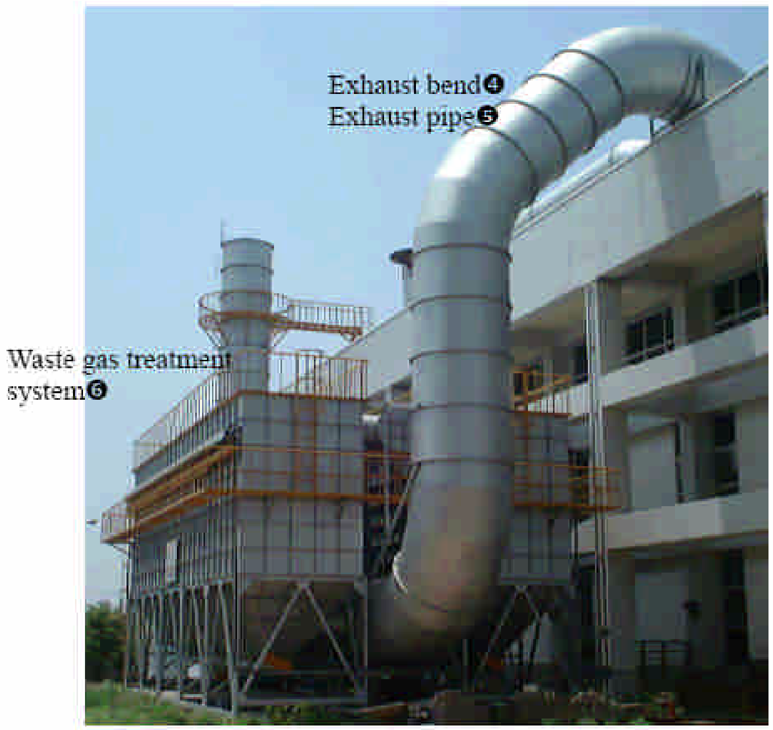
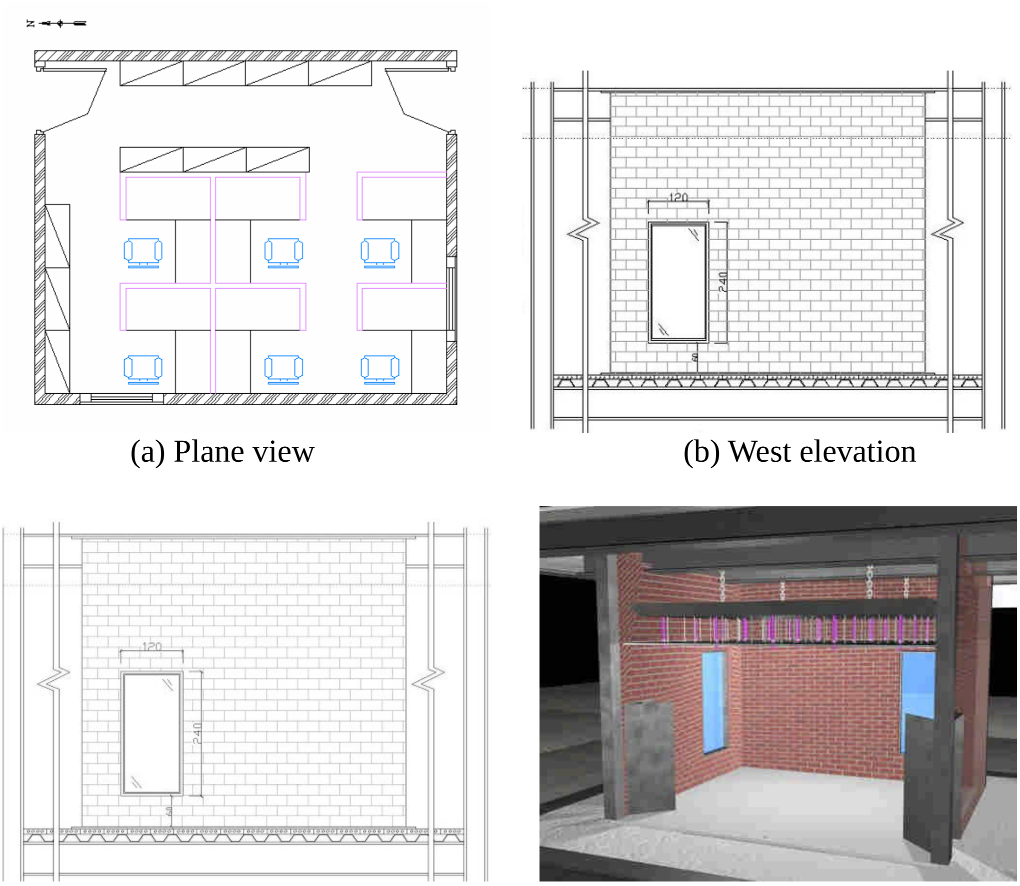


***Fig. 2**：Waste gas treatment system*

2.2 Investigated Model Office

The investigated model office, as shown in Fig. 3, is located below the smoke collection hood of the 10 MW fire test facility. The plane dimension is 6 m ×5 m (wall core line); the net ceiling height is 3.3 m; the walls are brick-laid in 0.26 m thickness using reinforced bricks. Both northeast and southeast wings have a 2.1 m × 0.9 m single door to be opened or closed, respectively. The ceiling is made of a light rigid frame and gypsum board. To better directly observe restraint of the fire via sprinkler actuation and water droplets, two 2.4 m × 1.2 m fireproof windows are placed at the north wing of the western wall and the east wing of the southern wall. The distance between the window and ground is 0.6 m. See elevation of west and south in Fig. 3(b) and 3(c); the overall 3D view is in Fig. 3(d).



(a) Plane view (b) West elevation

(c) South elevation (d) 3D view

Fig. 3 *: Schematic diagram of the investigated model office (not in scale)*

2.3 Sprinkler System

Under domestic regulations, the number of sprinklers is based on the effective protection area of each sprinkler. The protection diameter of the sprinklers used here is 2.3 m, meaning the maximum protection area is 10.56 m^2; the number of sprinklers is 5 × 6/10.56 = 3. Considering the appearance in actual design, one can have (r=2.3 m, S=$\sqrt{2}$r=3.25 m = sprinkler pitch) length: 6/3.25 = 2 sprinklers and width: 5/3.25 = 2 sprinklers. Four sprinklers are installed uniformly in the model room and placed 15 cm below the ceiling, as shown in Fig. 4. The end of each sprinkler pipe is connected to a pressure gauge, and quick joints report independent pressure observations and the stuffing of the water source. The sprinkler's K-factor is 80 LPM/(bar)$^{1/2}$, its temperature rating is 68°C, its response time index (RTI) is 131.54 (m s)$^{1/2}$, and its C-factor is 0.647 (m/s)$^{1/2}$.

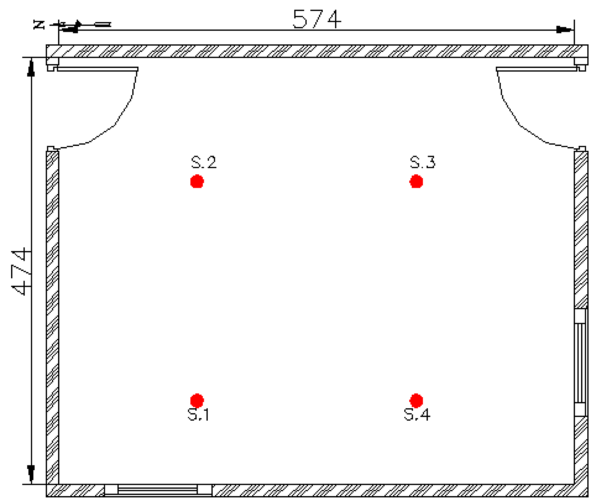


Fig. 4 *：Sprinkler installed location*

2.4 Experiment Planning

The interior layout is meant to mimic an actual office, as in Fig. 5, including six office chairs, six desk shields, six desk boards, three sets of short wooden cabinets (east side of office and close to the partition, see green word TAR2 in Fig. 5), four sets of medium wooden cabinets (east side of office, close to eastern wall, see green word TAR3 in Fig. 5), and three sets of tall wooden cabinets (north side of office, close to northern wall, see green word TAR4 in Fig. 5). The fire load of the room, including all furniture, is 11,892 MJ or approximately 390 MJ/m^2. The red broken-lined circle represents the fire source location. The 3-dimensional fire source is made of 0.5 kg paper in the plastic trash can (D25cm x H29.5cm) to burn the adjacent chair, desk, computer equipment and 20 kg paper on the desk to simulate the initial fire scenario. ISO 9705 test results show that the peak heat release rate and total heat release (THR) of this fire source is 30 KW and 14.22 MJ respectively. The space has four sprinklers. From the pre-test, sprinklers S_1~S_3 almost activate simultaneously, and the last one (S_4) activates later. To simulate failure of a sprinkler system, water is not supplied to S_1~S_3 but only to S_4 for 30 minutes (regulation requirement). Water pressure is kept at 2 kg/cm^2.

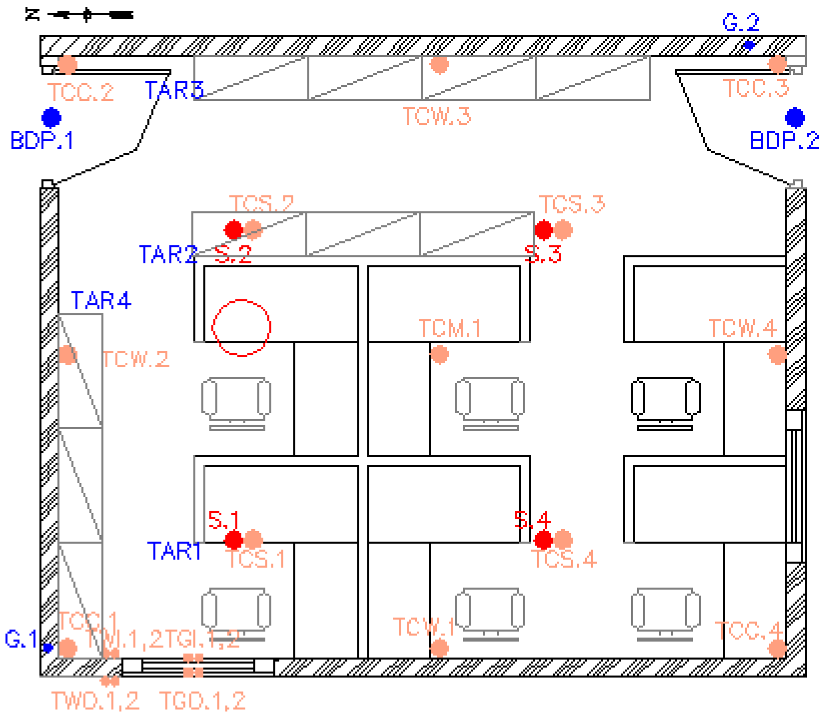


Fig. 5 *：Interior layout of the full-scale office fire experiment*

3. Results and Discussion

First, pre-tests without sprinklers were conducted in the same conditions, and flashover was observed to occur at 700 sec after ignition. In this study, the entire experiment takes around 3720 sec. At 110~120 sec after ignition, sprinklers S_1~S_3 are activated almost simultaneously. At 131 sec, sprinkler S_4 is activated and working. The entire sprinkling takes 30 minutes and successfully restrains fire growth. Flashover never appears. Fig. 6 record significant fire conditions in the whole process. Fig. 7 shows the heat releases describing the entire fire spread.

(a) View from the southern opening
(b) View from the southern opening
(c) View from the northern opening
(d) View from the northern opening
(e) View from the southern opening
(f) View from the western opening

Fig. 6 *: Full-scale office fire spread*

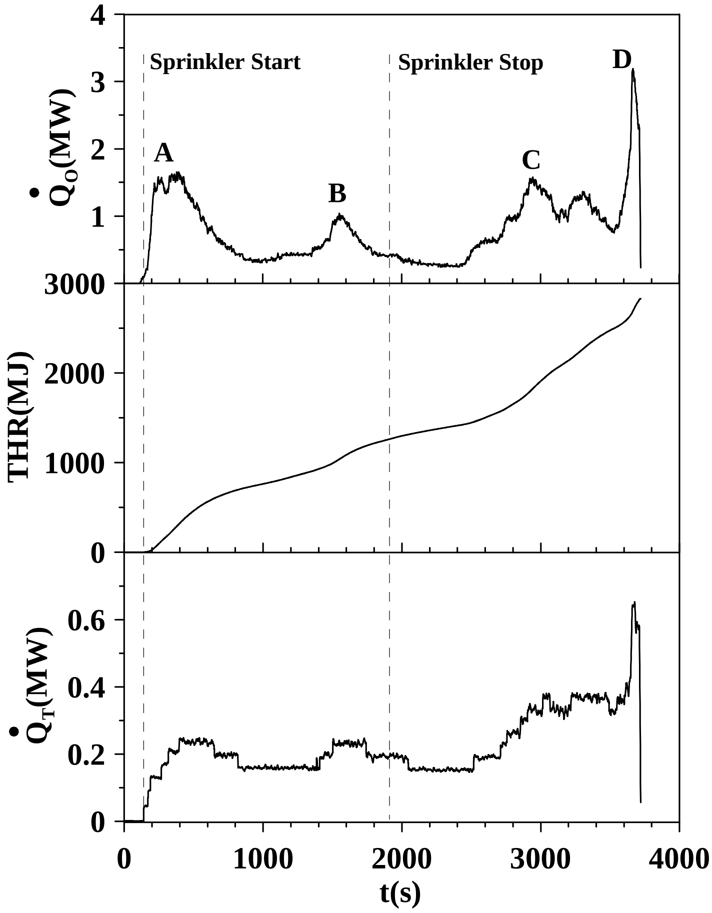


Fig. 7：*Heat releases in full-scale office fire*

In Fig. 7, $\dot{Q}_o$ denotes the heat release rate measured via the OC method; THR denotes the total heat release rate from $\dot{Q}_o$; $\dot{Q}_T$ denotes the convective heat release rate measured via GTR. The ratio of $\dot{Q}_T/\dot{Q}_o$ measured in the comparison pre-test (without sprinklers) is around 50%. Sprinkling reduces fire gas temperature, and thus the $\dot{Q}_T/\dot{Q}_o$ value in this study is much smaller (around 25%). THR reaches 4000 MJ at 3600 sec.

After complete burning of paper around the fire source at the office, the sprinklers are gradually activated from 110 sec. At around 200 sec, the heat release rate suddenly rises to 1.5 MW, and the fire source area is fully burning. Flame spread to the western desk (symbol TAR1 in Fig. 5) and short cabinet close to the east partition (symbol TAR2 in Fig. 5). Between 200 and 400 sec, the heat release rate is kept at a steady state, as shown in Fig. 7 point A. At 400 sec, influenced by continuous sprinkling, the heat release rate drops. When flame extends from the short cabinet to the medium cabinet on the eastern wall (symbol TAR3 in Fig. 5) at 1600 sec, the heat release rate reaches 1 MW, as in Fig. 7 point B. According to domestic regulations, emergency power is required to supply water for 30 minutes during fire. At 1920 sec, the water source for the sprinkler system is shut down. Due to the wetted furniture, the heat release rate reduces to less than 0.5 MW. At 2400 sec, the moisture in the furniture drops, and the heat release rate starts to grow. The fire then resumes at the medium cabinet near the eastern wall, and the heat release rate climbs to 1.5 MW at 3000 sec, as in Fig. 7 point C. At 3500 sec, the tall cabinet in the north (symbol

TAR4 in Fig. 5) starts burning, and the heat release rate increases to 3.2 MW. The teat release rate then reaches its maximum, as shown in Fig. 7 point D.

4. Conclusion

Sprinklers help control fire flashover. We have seen that, even with a purposeful failure of three of four sprinklers, a single functioning sprinkler can still control the fire spread. Although the fire is not completely extinguished, flashover is restrained for 30 minutes, effectively extending the office evacuation time. We have noted that once the sprinkler water is switched off after 30 minutes, the fire quickly resumes. In typical performance-based fire safety design, the number of installed sprinklers (in our case four) can be determined by office specifics (here, fire load is approximately 390 MJ/m^2). We have seen, however, that maintaining the amount of sprayed water is a more important consideration. One should be careful that providing too much water in the initial treatment of the fire might lead to the consumption of all of the water, at which point the fire quickly re-intensifies.

Acknowledgements

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Effects of acoustic properties of the Japanese Cedar decoration material on sound filed in the listening room

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Che-Ming Chiang[3]

ABSTRACT

In recent years, population of the discussion is about indoor environment of sustainable health in Taiwan. The wooden materials in green building materials are organism and porous properties. Furthermore, wooden materials appear frequency properties with different conformation, so that are important role of building acoustic. This research discusses the effect of acoustic properties of Japanese Cedar decoration materials for sound filed in the listening room. Initially, we compared the value that between measurement and simulation on sound field of the listening room. Results showed that linear regression relationship between measured and simulated of reverberation time and Clarity obtained over 0.7. Confirming is effective of the computer model on this study.

This study input materials properties that include sound-scattering coefficient and absorption coefficient in computer model. We discussed the factor of decoration rate and disposition of Japanese Cedar decoration materials on sound field for the listening room. Results showed that decoration percentage attained at twenty percent with Japanese Cedar decoration materials on sound field for the listening room, was noticeable variation with empty room. With the increase in the rate of Japanese Cedar decoration materials that increase on relative sound pressure level of each frequency. This study developed that wooden diffusers of Japanese Cedar averagely distributed in the listening room, were decreasing unevenness on sound pressure level of each receiver. And Clarity value increased with high frequency.

KEYWORDS

Listening Room, Japanese Cedar Decoration Materials, Sound-Scattering Coefficient, Sound Computer Model

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1. Introduction

There have been many research achievements on the acoustical adsorption and sound insulation performance as well as the applications of acoustical materials, both home and abroad. In recent years, random-incidence scattering coefficient of indoor decoration materials has also been an important parameter for the design of room acoustic design and an indispensable factor for material input of the design of various auditoria and computer simulation. Therefore, the scattering coefficient of decoration materials has been a focused topic of international researches.

In researches of acoustics, most institutes adopt music halls with large capacity as objects. This study, in accordance with the requirements for reuse of building space, targets at building listening room functions with RC structure buildings, which are commonly seen in Taiwan, and to discuss sound effects in smaller sound environments on the basis of theories from early researches, and to utilize the scattering and acoustical adsorption performances of wooden decoration materials to solve the sound defects. This study adopts wooden materials as main decoration materials for the measurement of material scattering coefficient. Since wood belongs to porous organic biomaterials, whose frequency characteristics are shown according to the structure, and wooden decoration materials has low cost and high recovery value, they play an important role in room acoustics.

This study carried out measurement of random-incidence scattering coefficient of wooden decoration materials in accordance with ISO17497-1 surface sound scattering characteristics. This study inputs random-incidence scattering coefficient and acoustical adsorption coefficient in parameters of numeric model materials so as to explore the impact of various variables like scattering coefficient on music listening space.

2. References

2.1 Sound field properties of listening room

It has been mentioned in early researches on acoustics that unexpected scattering effect is produced in music halls due to the large quantity of sculptures and splendid decorations. Acousticians have chosen to develop diffusible materials as substitute of indoor decorations in music halls (Beranek, 1994); Taiwanese scholar Rong-sheng, Lin (1996) mentioned in his study on the application of diffusible materials in rectangular halls that diffusible materials improve not only the uniformity of the distribution of sound energy in sound field, but also the smoothness of growth and attenuation speed of sound in the sound field. However, most researches are intended to discuss the physical characteristics of diffusible materials in large music halls, as for the design of listening environment in smaller spaces, it is much easier to meet the requirements of acoustic design than that in music halls or operas, according to the sound field conditions of room capacity, requirements for the frequency characteristics of reverberation time and scattering effects of sound field are emphasized (Kuo-Jung, Chiang, 2004). However, either adopting materials with better scattering effects or increasing furniture in the listening space may increase the diffusivity of sound in the space (Ikeda *et al.* ¸2005).

2.2 Scattering characteristics of material surfaces

Factors of indoor decoration influencing the diffusivity of sound field in the space include diffusion coefficient and scattering coefficient. Diffusion coefficient means the uniformity of the distribution of reflected sound energy in the space while scattering coefficient means the ratio of scattered sound energy to total reflected sound energy. Beranek mentioned that unexpected scattering effect is produced in music halls due to the large quantity of sculptures and splendid decorations. D'Antonio and Cox (2000) chose to develop diffusible materials as substitute of indoor decorations in music halls; Taiwanese scholar Wei-Hua, Chiang and his research team mentioned in their study on the application of diffusible materials in rectangular halls that diffusible materials improve not only the uniformity of the distribution of sound energy in sound field, but also the smoothness of growth and attenuation speed of sound in the sound field. In case mirror reflection dominates, reflected sound is provided with strong directivity, which will bring scattering effect to the sound filed, only under steady sound conditions and after multiple mirror reflections in a period of time can the sound environment with sufficient diffusion can be achieved. However, the so-called diffuse sound filed can only be produced in a considerable distance from the sound source, materials with surface scattering performance may cause earlier diffusion and more ideal diffuse sound filed conditions (Vorlander and Mommertz, 2000).

The surface scattering performance of Japanese Cedar decoration materials to be discussed in this study is helpful for providing better diffuse sound field for music listening spaces. According to the measurement method of ISO17497-1, this study has designed the auto measurement system for random-incidence scattering coefficient for measuring the scattering coefficient of Japanese Cedar decoration materials and variable discussion in numeric models.

3. Methods

3.1 Experiment Specification

This study, in accordance with the requirements for reuse of building space, targets at building listening room functions with RC structure buildings, which are commonly seen in Taiwan. The volume of the listening room is 44.41m^3 (L4.78m, W3.26m, H2.85m), walls and ceiling inside the room adopt smooth cement paint, the floor adopts ceramic tiles, the south side of the space is provided with French window and curtains.

Sound field measurement and analysis are mainly carried out for objective measurement of reverberation time and music clarity in accordance with ISO3382 hall reverberation test methods, Omni-source is adopted as the sound source of the measurement, 2-channel real time analyzer is adopted for recording and the measured results are calculated by software.

The interrupted noise method is adopted for the measurement, omni-source of the sound source device generates white noise after being amplified by the power amplifier, the sound source is turned off after the space is filled with stable sound source signals, and then the attenuation curve is analyzed by software; the receiving microphone should be located over 1m above any reflection surface; at least 3 measuring points should be provided, each point should be measured for 3 times continuously and the mean value should be adopted.

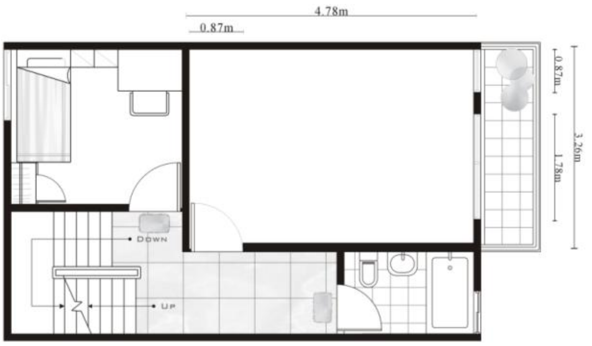


Figure 1:*Plan of the listening room.*

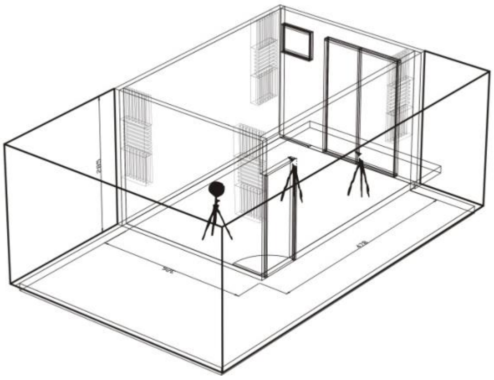


Figure 2:*Setting the sound source and measuring receivers for the listening room.*

3.2 Establishment of Simulation Models on the Listening room

This study adopts the EASE4.1 (Enhanced Acoustic Simulator Engineer) acoustic performance simulation software as the tool for exploring variables of the music listening space, this software analyzes out numeric simulation models on the basis of the ray tracing principle. The numeric models establish properties of shape, volume and materials of the room according to current situation and basic conditions of the space, and carry out on-site measurement and analysis of reverberation time and music clarity as well as comparison between numeric models so as to verify the validity of numeric models.

Table1. Conditions of the computer model for the listening room.

Materials setting in computer model	Materials Area（m²）
Tile floor	15.58
Concrete s(smooth)	39.85
Concrete s(smooth)	15.58
Wind glass	0.38
Door hollow(door)	1.84
Window DP Drape	4.16

3.3 Properties of Japanese Cedar decoration material

This study adopts Cryptomeria japonica var. japonica (Japanese Cedar) as the test material, which is sampled from afforestation trees in Forest Land No. 7, Hsinchu Forest District Office, the tree is about 25~30 years old when cut, the air-dried specific gravity is 0.40, the water content ratio is 14.11%, the sap wood is in off-white and the heartwood is in red or dark hazel.

Dimensions of the test material complies with ISO17497-1 stipulations for measurement, after calculation according to the scaling-down ratio of N=2 according to the volume of the reverberation room, it is the Japanese Cedar decoration material with the bottom board dimensions of 60 cm×60 cm and the interval is 3 cm. During actual decoration, the actual dimensions of the Japanese Cedar decoration material should be multiplied by 2 times to suit the actual dimensions.

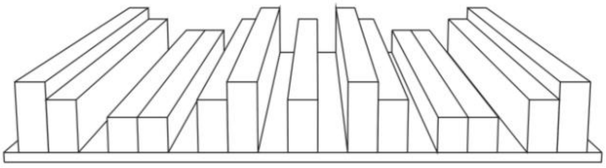


Figure 3:*Japanese Cedar decoration material.*

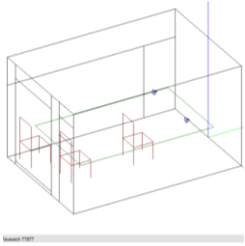
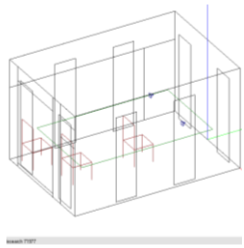
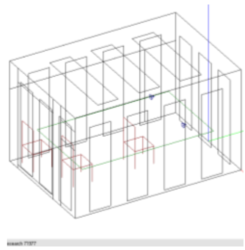
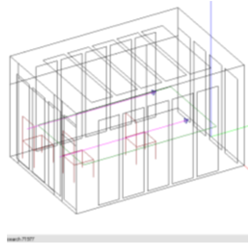
Table2. Scattering and absorption coefficient of Japanese Cedar decoration material.

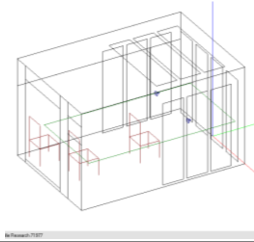
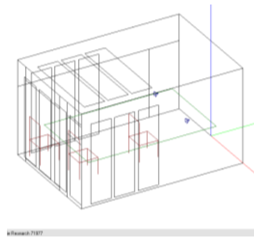
Frequency （Hz）	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Scattering coefficient	0.10	0.33	0.37	0.57	0.89	0.58	0.56	0.70	0.66	0.88	0.90	0.73	0.76	0.63
Absorption coefficient	0.04	0.09	0.09	0.10	0.08	0.26	0.15	0.39	0.26	0.21	0.22	0.19	0.22	0.23

3.4 Factor Conditions of the Listening Room

After verifying the validity of numeric models, this study also changed conditions in conjunction with the application of Japanese Cedar decoration material so as to explore the impact of Japanese Cedar decoration material on the sound field in different decoration ratio and locations of the listening room.

Table3. Factor conditions of the listening room.

Decoration percent of Japanese Cedar decoration materials in the listening room				
Factor Conditions	A1 empty room volume 44.41 m^3 total surface 76.99 m^2	A2 20% decoration volume 44.41 m^3 total surface 88.51 m^2	A3 40% decoration volume 44.41 m^3 total surface 101.47 m^2	A4 60% decoration volume 44.41 m^3 total surface 110.11 m^2
model				

Distribution of Japanese Cedar decoration materials in the listening room		
Factor Conditions	B-1 front of the listening room volume 44.41m^3 total surface 95.71m^2	B-2 rear of the listening room volume 44.41m^3 total surface 95.71m^2
model		

4. Discussion

4.1 Comparison of Measuring and Simulating on the Listening Room

Based the reality conditions created the models processed the RT and clarity for compared the simulation data close the reality data or not. Table 4 showed the deviation percent are 0.1~14.9% when RT on 250Hz~8000Hz, the RT linear regression relationship R2 was 0.9715. Table 5 showed music clarity between reality and simulation data average values are 2.8, 2.4 on 250Hz~8000Hz, the difference value was 0.4 dB. Clarity linear regression relationship R2 was 0.8825, it confirmed the two data had the same trend. After the RT and Clarity comparison, it proved the simulation data was effective for investigation interior sound field.

Table4. Comparison of measuring and simulating for RT.

Frequency（Hz）	250	500	1000	2000	4000	8000
Measuring RT（sec）	2.91	1.94	1.76	1.69	1.30	0.92
Simulating RT（sec）	3.26	2.06	1.78	1.94	1.3	0.84
Different（sec）	0.35	0.12	0.02	0.25	0.00	0.08
Different Percen（%）	12.1	6.0	1.0	14.9	0.1	8.6

Table5. Comparison of measuring and simulating for for Clarity.

Frequency（Hz）	250	500	1000	2000	4000	8000
Measuring Clarity（dB）	-2.4	-0.6	1.4	1.0	2.7	4.4
Simulating Clarity（dB）	-4.1	-1.7	-0.9	0.3	1.1	4.1

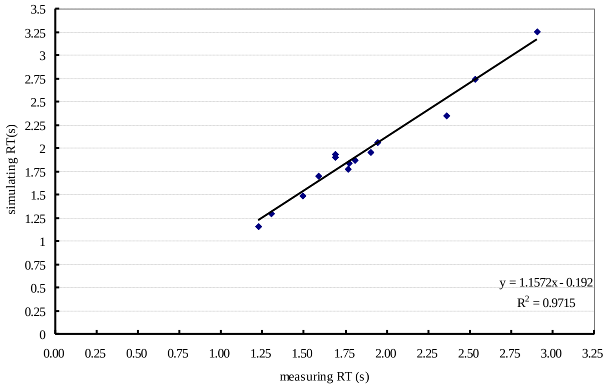


Figure 4:*Linear regression relationship between measuring and simulating of RT on the listening room.*

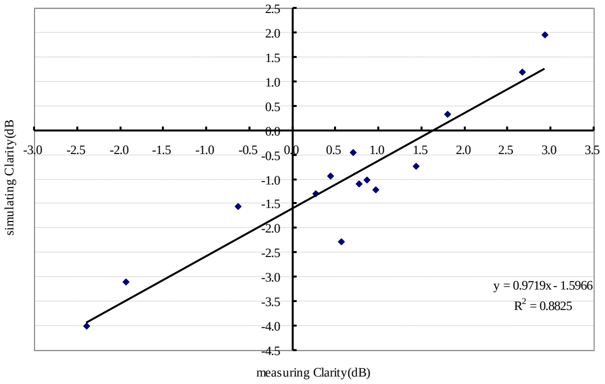


Figure 5:*Linear regression relationship between measuring and simulating of Clarity on the listening room.*

4.2 Effects of Japanese Cedar decoration materials in the listening

4.2.1 Decoration percent of Japanese Cedar decoration materials

Fig. 6 showed the sound pressure reduced from A1 mode 118.14dB to A4 mode 113.54dB when increased decoration percent the sound pressure will reduce. Each mode from 2.06sec to 0.57sec on 500Hz because of the Japanese Cedar decoration materials had the absorption from the gap lower the RT.

Fig. 7 showed SPL (sound pressure level) of A1-A4 modes. The SPL were 2.93~0.24dB on each frequency in A1 mode; except the 250Hz was 1.56dB the rest of other frequencies were under 1dB in A2 mode. When increased Japanese Cedar decoration materials the SPL will be increase on each frequency; the SPL increased to 3.29dB on 250Hz in A4 mode was the highest value in each mode. Through average SPL of frequencies 250~5k Hz were 0.50dB and 0.75dB less than N1 average 0.85dB. A4 were 1.02dB.

Fig. 8 showed simulation results in A1-A4 modes. In each mode R1 receive spot will get the high clarity value when receive spot near the sound source. Increased the Japanese Cedar decoration materials could increased the clarity value especially the decoration 60%, the result displayed narrow the three of receive spots difference when the decoration materials increased. It means the scattering coefficient could improve the different listening sensibility on sound field.

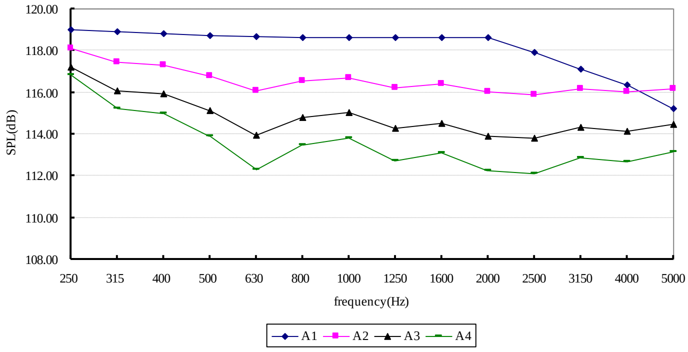


Figure 6:*Comparison of SPL on A1-A4.*

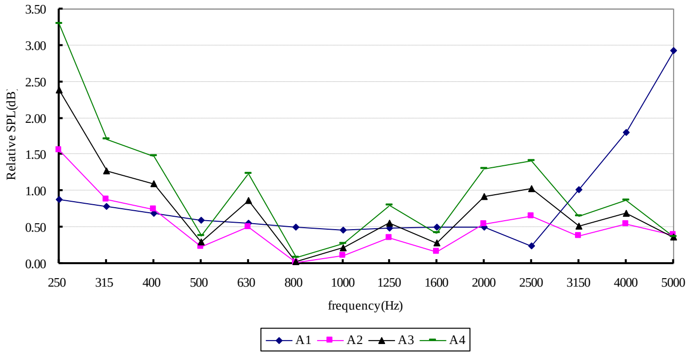
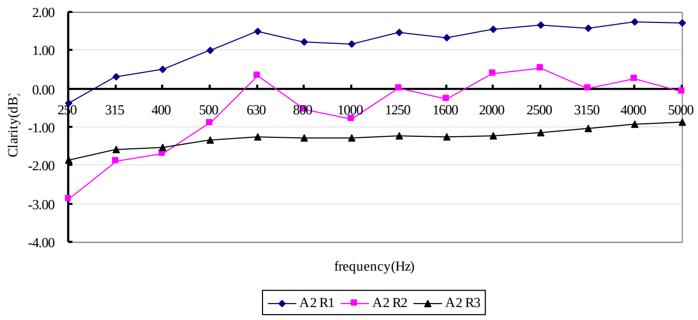
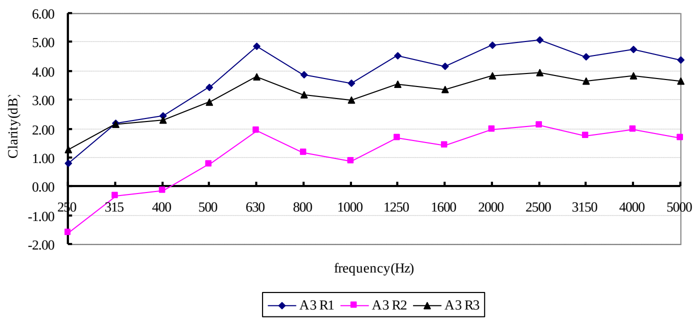


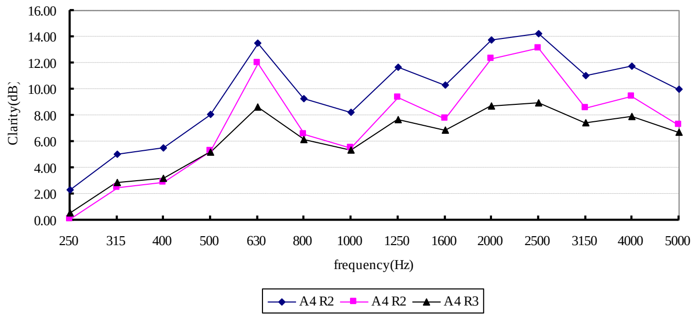
Figure 7:*Comparison of relative sound pressure level on A1-A4.*



（a ）20% decoration of Japanese Cedar decoration materials for A2.



（b ）40% decoration of Japanese Cedar decoration materials for A3.



（c ）60% decoration of Japanese Cedar decoration materials for A4.

Figure 8:*Comparison of Clarity with decoration of Japanese Cedar decoration materials on each receive.*

4.2.2 Distribution of Japanese Cedar decoration materials

Fig. 9 result showed the SPL of front area will be lower than back area when the Japanese Cedar decoration materials setting in listening room.

Fig. 10 result showed the SPL of B1 mode were between 0.23~4.63dB lower than B2 0.43~4.86dB, but either the B1 or B2 were lower than ±5dB from the references suggestion. Input the SPL values from A1 and A3 to this mode will find the SPL higher than N1 empty room when setting the Japanese Cedar decoration materials into front area and back area. According A2-A4 SPL values, A2 was between 0.02~1.56dB, A3 was between 0.03~2.39dB, each SPL of them were lower than A1. Because of the B1, B2 decoration area were 18.72m2 between 11.52 m2 and 24.48 m2 of A2, A3, so the decoration positions had obvious effect.

Fig. 11 showed the effect of clarity when the Japanese Cedar decoration materials setting in front area and back area. B1 and B2 clarity were over 4dB, the clarity increased on the high frequency. The data of three receive spots will be close when setting Japanese Cedar decoration materials in back area.

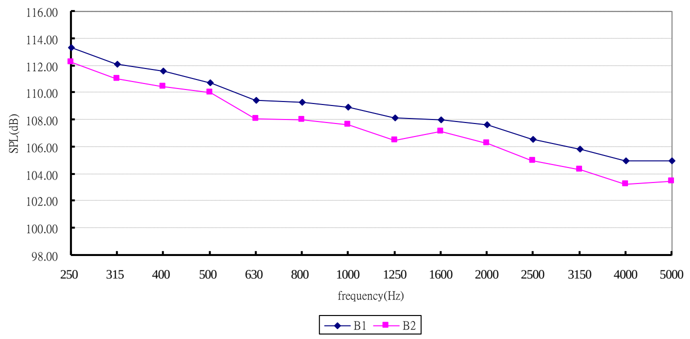


Figure 9:*Comparison of SPL on B1and B2.*

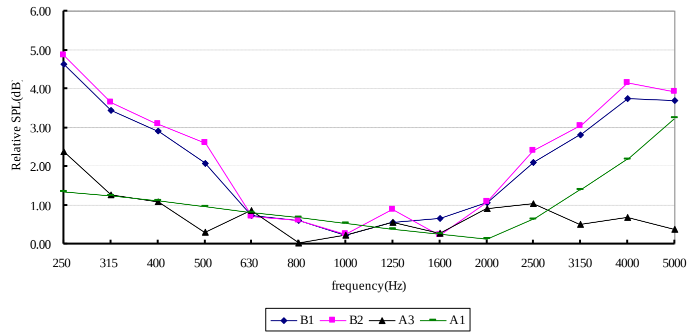
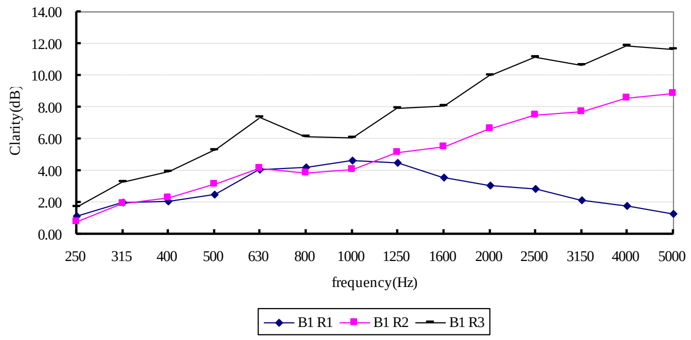
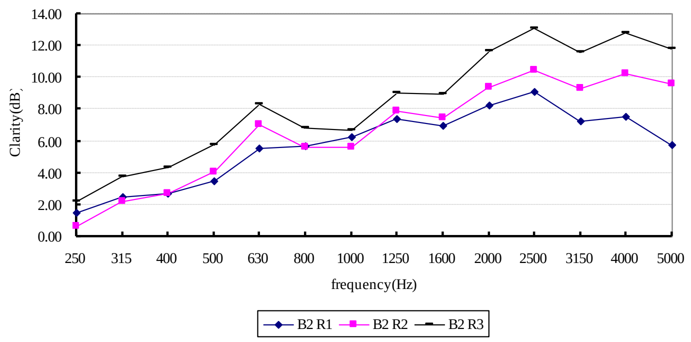


Figure 10:*Comparison of relative sound pressure level on 1B1 、B2 、A3 、A1.*



（a ）Japanese Cedar decoration materials in the front of the listening room



（b ）Japanese Cedar decoration materials to the rear of the listening room

Figure 11:*Comparison of Clarity with different distribution of Japanese Cedar decoration materials on each receive.*

5. Conclusion

This study established the function of listening room on reinforced concrete building at Taiwan. The result showed two data had the same trend between measuring and simulating for RT and Clarity that linear regression relationship R^2 were more than 0.7. Further, we set data of Japanese Cedar decoration materials in the computer model, and discussed effects of Japanese Cedar decoration materials on sound filed in the listening room.

While decoration percent of Japanese Cedar decoration materials were to 20% on sound filed that showed conspicuous variation between the empty room type and 20% decoration type. Standard deviation values about 40% and 60% decoration type were more than the empty room type on middle-low and middle –high frequency for each receiver, and exhibited distribution non-uniformity on SPL. We conjectured that the sound filed get diffused condition with decoration percent of Japanese Cedar decoration materials were to 20%. Nevertheless, we used Japanese Cedar decoration materials excessively that get the result with absorption of the material.

The sound filed obtained uniformity Clarity on each recevier with decoration materials by the rear listening room. The type of distribution Japanese Cedar decoration materials that were concentrated in the listening room, and standard deviation values were more than the type of 40% decoration on each receiver. Therefore Japanese Cedar decoration materials were uniform applied on the sound filed, and that decreased the result of distribution no-uniformity on each recevier for SPL.

6. References

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FM2 Full Member Fee Category **2** | Medium size research Institutes; Public agencies with major research interest; Companies with major research interest

FM3 Full Member Fee Category **3** | Information centres of national standing; Organisations normally in Category 4 or 5 which prefer to be a Full Member

AM1 Associate Member Fee Category **4** | Sectoral research & documentation institutes; Institutes for standardisation; Companies, consultants, contractors etc.; Professional associations

AM2 Associate Member Fee Category **5** | Departments, faculties, schools or colleges of universities or technical Institutes of higher education (Universities only)

IM Individual Member Fee Category **6** | Individuals having an interest in the activities of CIB (not representing an organisation)

Fee Reduction:
A reduction is offered to all fee levels in the magnitude of 50% for Members in countries with a GNIpc less than USD 1000 and a reduction to all fee levels in the magnitude of 25% for Members in countries with a GNIpc between USD 1000 – 7000, as defined by the Worldbank. (see http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNIPC.pdf)

Reward for Prompt Payment:
All above indicated fee amounts will be increased by 10%. Members will subsequently be rewarded a 10% reduction in case of actual payment received within 3 months after the invoice date.

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CIB General Secretariat:
e-mail: secretariat@cibworld.nl

PO Box 1837, 3000 BV Rotterdam, The Netherlands
Phone +31-10-4110240;
Fax +31-10-4334372
Http://www.cibworld.nl

Table of Contents

WELCOME TO CIB-W096 2009 TAIWAN

We are honored and pleased to welcome you to the International Symposium CIB-W096 2009, Taiwan. There will be four keynote speeches and 32 papers presented to stimulate discourses around emerging issues on Architectural Management.

As we are celebrating the founding anniversary of NCKU, we are happy to inform you that the Environment and Art Festival will be inaugurated in November, although the display of art works has started since June. The exhibition features collections of Chi Mei Museum and more than one hundred works by eighty individuals and teams.

During the art festival “Dialogues between Generations”, the contemporary young artists will initiate dialogues with their established predecessors in terms of sculptures, installation art and digital creation. Our visiting guests will have the opportunity to know and become engaged with the environment via their dialogues.

We hope you enjoy the trip, the conference events as well as the environment brought to you by your friends here in Tainan.

Chun-Ta Tzeng

Stephen Emmitt

Matthijs Prins

Taiwan, November 2009.

GENERAL INFORMATION

Date: 02-04 November, 2009

Venue: National Cheng Kung University

Organizers:

- *Dr. Chun-Ta Tzeng*
  Associate Professor
  Department of Architecture,
  National Cheng Kung University, Taiwan

- *Dr. Stephen Emmitt*
  Professor
  Department of Civil and Building Engineering,
  Loughborough University, UK

- *Dr. Matthijs Prins*
  Associate Professor
  Department of Architecture,
  Delft University of Technology, Netherlands

Sponsors:

- *International Council for Research and Innovation in Building and Construction (CIB)/W096- Architectural Management*
- *National Science Council, Taiwan*
- *Department of Architecture, National Cheng Kung University*

Co-sponsors:

- *Architecture and Building Research Institute, Ministry of the Interior (ABRI)*
- *Construction and Planning Agency, Ministry of the Interior (CPAMI)*
- *Architectural Institute of the Republic of China*

Website: 140.116.205.15/CIB-W096_2009_Taiwan/

TRANSPORTATION

Visiting Kuang-Fu Campus of National Cheng Kung University (NCKU):

(a) Driving Directions

From the North-

1. Take National Freeway No.1 (Sun Yat-Sen Freeway) southbound.
2. Get off at Exit 319 (Yongkang Interchange) and turn right to southbound Zhongzheng N. Road.
3. Travel down on Chungcheng N. Road and Chungcheng S. Road, and make a left turn at Chunghwa Road.
4. Drive down Chunghwa Road and Chunghwa East Road.
5. Turn right at Shiaodong Road and travel along it for a few blocks further, about 1.2 km, to reach NCKU.

(If you drive on National Freeway No.3 Southbound, at Exit 346 (Shinhua System), take National Freeway No.8 Westbound (Exit 6, Tainan System Interchange) to get on National Freeway No.1 Southbound to Exit 319)

From the South-

1. Take National Freeway No.1 (Sun Yat-Sen Freeway) northbound.
2. Get off at Exit 327 (Tainan Interchange) and turn left to westbound Chungshang Road.
3. Travel on Chungshang Road and continue on Dongmen Road.
4. Make a right turn at either Chang Rung Road or Sheng-Li Road, and travel for about 1.1 km to NCKU.

(If you take National Freeway No.3 Northbound, at Exit 357 (Guanmiao Interchange), take No.86 Expressway westbound (Exit 8, Rende System Interchange) to get on National Freeway No.1 northbound to Exit 327)

(b) Public Transportation

By Train

1. Take TRA Train to Tainan Station.
2. NCKU is located on Ta-Shueh (University) Road, about 100m from the rear entrance of Tainan Station.

By THSR (Taiwan High Speed Rail)

1. Take Taiwan High Speed Rail to Tainan Station
2. Take the free shuttle bus, which takes about 40 mins to NCKU, and get off at the bus stop of Tzu-Chiang Campus or Shiaodong Road to visit Cheng-Kung Campus, Kuang-Fu Campus and Chien-Kuo Campus.

For more information on the shuttle to / from THSR Station:
http://www.thsrc.com.tw/en/travel/transfer_info.asp.

From Kaohsiung International Airport (KHH)

1. Take Kaohsiung MRT from the Airport Station (R4) to Kaohsiung Main Station (R11) for TRA Train or Zuoying HSR Station (R16).

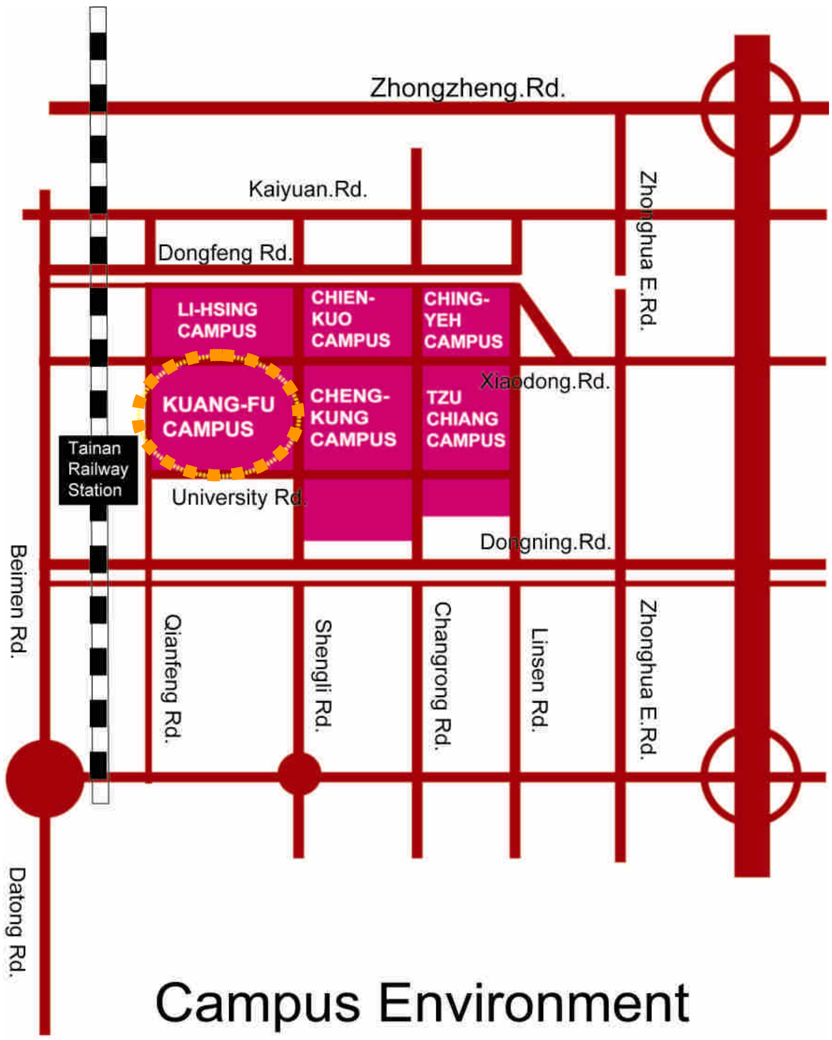
2. (a) Take the THSR Train from Zuoying to Tainan Station, and the traveling time is about 15 minutes, or

   (b) Take TRA from Kaohsiung Main Station to Tainan TRA Station, which usually takes about 35 minutes on express trains.

From Taiwan Taoyuan International Airport (TPE)

1. Take a taxi or shuttle bus from the airport to THSR Taoyuan Station, which takes about 20 minutes.

2. Take the THSR train from Taoyuan Station to Tainan Station.



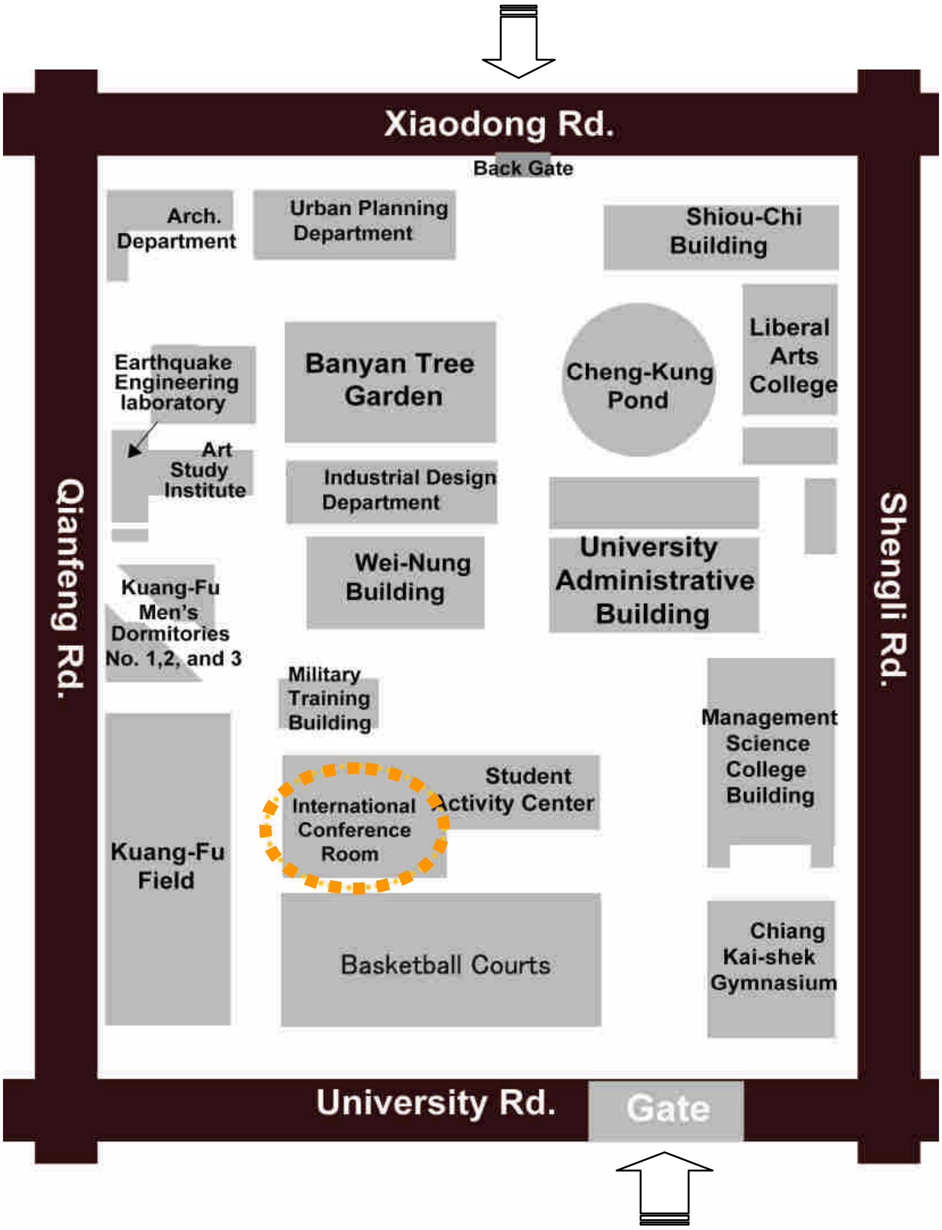
Campus Environment

CAMPUS INFORMATION

National Cheng Kung University (NCKU) is located in Tainan City, Taiwan. It is situated across from the Tainan Railway Station, offering convenient transportation. The total area of the school is 172.629294 hectares, including the Cheng-Kung, Sheng-Li, Kuang-Fu, Chien-Kuo, Tzu-Chiang, Ching-Yeh, Li-Hsing, and Kuei-Jen Campuses, as well as the An-Nan Campus and some areas designated for dormitory use. It is one of the most spacious and beautiful university campuses in Taiwan.

The symposium takes place in the International Conference Room on Kuang-Fu Campus.

Please refer to the map below:



KUANG-FU CAMPUS

REGISTRATION

The registration desk is set at the main entrance hall of the International Conference Center on Kuang-Fu Campus (please refer to the floor plan on page 16).

CONFERENCE AGENDA

The Symposium will address the following architectural management themes:

Theme 1.
Sustainable architectural design management and public policy

Theme 2.
Integrated design – the changing role of AEC organizations

Theme 3.
Management, preservation and reconstruction of historical buildings

Theme 4.
Emergent management paradigms in Architectural Management

Theme 5.
Applications of architectural environment control and management technologies

Monday November 02

Day 1	Auditorium A	Auditorium B	Auditorium C
0840~0910	Registration		
0910~0940	Opening Ceremony		
0940~1030	Keynote Speech I Prof. Stephen Emmitt, Loughborough University, UK		
1030~1100	Break		
1100~1150	Keynote Speech II Dr. Matthijs Prins, Delft University of Technology, Netherlands		
1150~1330	Luncheon		
1330~1350	Foyer	Theme 1 1007 Hsieh, Horng-Chang	Theme 1 1032 Chang, Chia-Chang et al
1350~1410		Theme 1 1008 Chen, Wei-Tong et al	Theme 1 1035 Su, Chih-Hsun et al
1410~1430		Theme 1 1025 Wu, Yu-Cheng	Theme 1 1039 Huang, Hao et al
1430~1450		Theme 1 1028 Tseng, Pong-Kuang et al	Theme 1 1040 Hsieh, Ting-Ting et al
1450~1510	Break		
1510~1530	Foyer	Theme 1 1045 Zhang, Heng et al	Theme 2 2020 Mak, Michael Y. et al
1530~1550		Theme 1 1052 Shen, Chin-Chi et al	Theme 2 2031 Quanjel, Emile et al
1550~1610		Theme 1 1058 Ding, Yuh-Chyurn et al	Theme 2 2054 Sengonzi, Ruth et al
1610~1630		Theme 1 1060 Chang, Kuei-Feng et al	Theme 2 3057 Sebastian, Rizal et al
1630~1730	Freshen up CIB-W096 Business Meeting		
1730~1830			
1830~2100	Welcome Party		

Tuesday November 03

Day 2	Auditorium A	Auditorium B	Auditorium C
0910~0940	Registration		
0940~1030	Keynote Speech III Prof. Yeng-Horng Perng, National Taiwan University of Science and Technology, Taiwan		
1030~1100	Break		
1100~1150	Keynote Speech IV Dr. A.F.H.J. den Otter University of Technology Eindhoven (TU/e) , Netherlands		
1150~1330	Luncheon		
1330~1350	Foyer	Theme 3 4044 Song, Hung-Chi et al	Theme 4 6002 Qu, Lu et al
1350~1410		Theme 3 4049 Huang, Li-Mei et al	Theme 4 6003 Siva, Jessica P S et al
1410~1430		Theme 5 7006 Tseng, Wei-Wen et al	Theme 4 6042 Deng, Ying et al
1430~1450		Theme 5 7014 Lau, Kwai-Wing et al	Theme 4 6053 Otter, Ad F. den et al
1450~1510	Break		
1510~1530	Foyer	Theme 5 7022 Chen, Hsuan-Jui et al	Theme 5 7029 Chen, Ko-Jen et al
1530~1550		Theme 5 7023 Chen, Hsuan-Jui et al	Theme 5 7036 Huang, Hui-Hsiung et al
1550~1610		Theme 5 7027 Lin, Bih-Chuan et al	Theme 5 7038 Chiu, Min-Sheng et al
1610~1630			Theme 5 7047 Fong, Jun-Hao et al
1630~1730	Round Table Meeting		
1730~1830	Closing Address		
1830~2100	Farewell Party		

Wednesday November 04

Day 3	*Technical and Cultural Tour*
0840~0910	Gathering (Kuang-Fu Campus, NCKU)
0910~0940	Leave for Tainan County by bus
0940~1130	Technical Tour Visit Architecture and Building Research Institute, Ministry of the Interior
1130~1150	Return to Tainan City
1150~1430	Luncheon (Hundred-year-old Noodle Shop)
1430~1730	Cultural Tour Anping National Historical Park
1730~1830	Return to Tainan City
1830~2100	Dinner (Ashia Restaurant)

KEYNOTE SPEECHES

Speaker	Topic	Time (Auditorium)
Prof. Stephen Emmitt, Loughborough University, United Kingdom	Management in Architecture: insights and developments	Nov. 02, 2009 Day 1 0940~1030 (**A**)
Dr. Matthijs Prins, Delft University of Technology, Netherlands	Architectural Design Management; Essence of the domain and future challenges	Nov. 02, 2009 Day 1 1100~1150 (**A**)
Prof. Yeng-Horng Perng, National Taiwan University of Science and Technology, Taiwan	Taipei Beautiful: How does government policy affect architectural management	Nov. 03, 2009 Day 2 0940~1030 (**A**)
Dr. A.F.H.J. den Otter University of Technology Eindhoven (TU/e) , Netherlands	Value and challenge of virtual collaboration and communication in architectural design	Nov. 03, 2009 Day 2 1100~1150 (**A**)

PAPER PRESENTATION

Theme 1: Sustainable architectural design management and public policy

Author No.	Author	Topic	Time (Auditorium)
1007	Hsieh, Horng-Chang	Performing Building Projects, Constructing Planned Fiasco: An Appraisal of the Autopoietic Spatial Configuration of City Plans, Design Codes, and Project Managements at a High-Profiled District in Kaohsiung	Day 1 1330~1350 (B)
1008	Chen, Wei Tong, Chen, Hong-Long Chang, Po-Yi	A Framework of User-Based Design Satisfaction Measurement for Element School Construction	Day 1 1350~1410 (B)
1025	Wu, Yu-Cheng	Managing the improvement of a city's public realm - the case of Chiayi City's chief townscape consultant project 2005, 7 - 2006, 12	Day 1 1410~1430 (B)
1028	Tseng, Pong-Kuang Chiang, Che-Ming Hu, Hsueh-Yen Chen, Chau-Yau	The Externality of Building Violations in Urban Environment- Empirical Observation in Taiwan	Day 1 1430~1450 (B)
1032	Chang, Chia-Chang Chiang, Che-Ming	Southern Taiwan Science Park's Policy for Sustainable Eco- Science Park	Day 1 1330~1350 (C)
1035	Su, Chih-Hsun Chiang, Che-Ming Chou, Po-Cheng Chang, Kuei-Feng	Utilizing CASBEE to Assess the Kaohsiung Modernized Comprehensive Stadium	Day 1 1350~1410 (C)
1039	Huang, Hao Chiang, Che-Ming Lin, Tie-Shyong Yeh, Hsien-Liang	Application of Green Building Ecological Index Group to Assess Ecological Quality of University Campuses	Day 1 1410~1430 (C)
1040	Hsieh, Ting-Ting Chiang, Che-Ming Chen, Jui-Ling Lai, Kwang-Pang	Taiwan Green Building Material Labeling System and its comparison with international labeling systems	Day 1 1430~1450 (C)
1045	Zhang, Heng Lei, Siu-Lai	Environmental Efficiency of Functionality for Residential Buildings in Taiwan	Day 1 1510~1530 (B)
1052	Shen, Chin-Chi Tzeng, Chun-Ta	Maintenance and Management of Ecological Campuses – A Case Study in West Cigu Campus, National University of Tainan	Day 1 1530~1550 (B)
1058	Ding, Yuh-Chyurn Ho, Chia-Wei	The New System to Assist Examining the Construction License	Day 1 1550~1610 (B)
1060	Chang, Kuei-Feng Chou, Po-Cheng	Sustainable building at the right perceived value of the real estate market	Day 1 1610~1630 (B)

Theme 2: Integrated design – the changing role of AEC organizations

Author No.	Author	Topic	Time (Auditorium)
2020	Mak, Michael Y. Ng, S. Thomas	Feng Shui: A Chinese approach to integrated design	Day 1 1510~1530 (C)
2031	Quanjel, Emile Otter, Ad F. den Zeiler, Wim	Workshops as practicum's to improve integration and knowledge exchange in collaborative design	Day 1 1530~1550 (C)
2054	Sengonzi, Ruth Emmitt, Stephen Demian, Peter	Challenges in negotiating trade-offs in pre-design briefing of healthcare projects	Day 1 1550~1610 (C)
3057	Sebastian, Rizal Haak, Willem Vos, Eric	BIM Application for Integrated Design and Engineering in Small-Scale Housing Development: a Pilot Project in The Netherlands	Day 1 1610~1630 (C)

Theme 3: Management, preservation and reconstruction of historical buildings

Author No	Author	Topic	Time (Auditorium)
4044	Song, Hung-Chi Chen, Shih-Ming	A study on establishing a General Theory and an Operational Model with the Settlement Preservation in Taiwan's Historical Urban Area	Day 2 1330~1350 (B)
4049	Huang, Li-Mei Tzeng, Chun-Ta	The Refurbishment and Management of Aboriginal Dwellings: The Traditional Paiwan Slabstone House	Day 2 1350~1410 (B)

Theme 4: Emergent management paradigms in Architectural Management

Author No	Author	Topic	Time (Auditorium)
6002	Qu, Lu Chow, Wan-Ki.	Numerical Studies on Emergence Ventilation System in Public Transport Interchanges	Day 2 1330~1350 (C)
6003	Siva, Jessica P S London, Kerry	Habitus shock: a model for architect-client relationships on house projects based on sociological and psychological perspectives Client management on house projects: facilitating client leaning for successful architect-client relationships	Day 2 1350~1410 (C)
6042	Deng, Ying Poon, S.W.	Mega-Challenges: Programming Management for Event Projects	Day 2 1410~1430 (C)
6053	Otter, Ad F. den Emmitt, Stephen	Architectural Design Management - a practical reflection on the development of a domain	Day 2 1430~1450 (C)

Theme 5: Applications of architectural environment control and management technologies

Author No	Author	Topic	Time (Auditorium)
7006	Tseng, Wei-Wen Shen, Tzu-Sheng Kao, Shiue-Shian	Evacuation Safety Countermeasures for the 3-Rail Co-construction of Taipei Main Station	Day 2 1410~1430 (B)
7014	Lau, Kwai-Wing Chow, Wan-Ki	Fire safety management system in modern high-rise buildings - Hong Kong perspective	Day 2 1430~1450 (B)
7022	Chen, Hsuan-Jui Tsai, Chih-Ta	A Study of the a-Si PV Module on the Mounting Position and Inclination Angle	Day 2 1510~1530 (B)
7023	Chen, Hsuan-Jui Chen, Joeng-Shein Chiang, Che-Ming	Taiwan PV Energy Policy of Conservation Energy and Reduction CO^2 on ITRI's Promotion Projects of Photovoltaic Building	Day 2 1530~1550 (B)
7027	Lin, Bih-Chuan Chiang, Che-Ming Selfridage, O. J.	How universal design works on Taiwanese Houses	Day 2 1550~1610 (B)
7029	Chen, Ko-Jen Tzeng, Chun-Ta Lai, Chi-Ming	Influence of fire source locations on the actuation of wet-type sprinklers in an office fire	Day 2 1510~1530 (C)
7036	Huang, Hui-Hsiung Chiang, Che-Ming Chou, Po-Cheng Chang, Kuei-Feng Kuo, Yi-Chun	Considering SB environmental assessment tool for the performance of buildings in Taiwan	Day 2 1530~1550 (C)
7038	Chiu, Min-Sheng Tzeng, Chun-Ta Lin, Ta-Hui	Fire Experiment in an Office with Partial Failure of Sprinkler System	Day 2 1550~1610 (C)
7047	Fong, Jun-Hao Lin, Fang-Min Chung, Chi-Min	Effects of acoustic properties of the Japanese Cedar decoration material on sound filed in the listening room	Day 2 1610~1630 (C)

SCIENTIFIC COMMITTEE

Professor Che-Ming Chiang, Taiwan

Professor Cheng-Li Cheng, Taiwan

Professor Stephen Emmitt, United Kingdom

Geir Hansen, Norway

Professor Per Anker Jensen, Denmark

Dr. Rachael Luck, United Kingdom

Professor Kerry London, Australia

Professor Silvio Melhado, Brazil

Dr. Cecilie Flyen Oyen, Norway

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Dr. Matthijs Prins, Netherlands

Professor Jouke Post, Netherlands

Professor Yeng-Horng Perng, Taiwan

Jarmo Antero Raveala, Finland

Dr. Ingrid Svetoft, Sweden

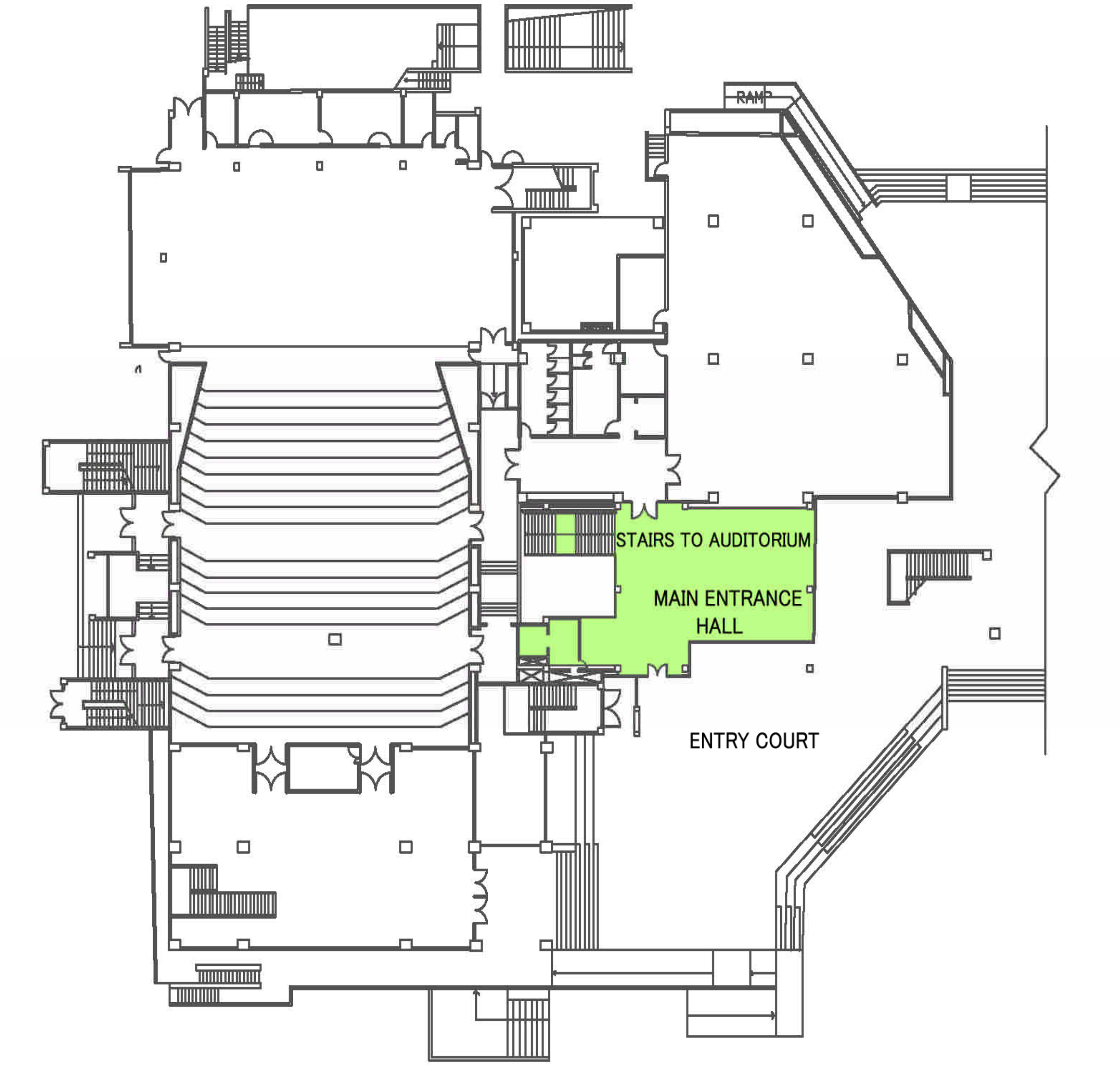
Dr. Chun-Ta Tzeng, Taiwan

Professor Guan-Hsiung Yang, Taiwan

VENUE FLOOR PLANS (International Conference Room)

Ground Level (F1)

Registration Desk



Basement Level (BF1)

Presentation Auditoriums

SOCIAL EVENTS

Welcome Party

The welcome party on day 1 (Nov. 02) will be held at the Corner Steak House at 18:30. This restaurant is in close proximity to the symposium venue. It is roughly a 6-minute walk. Please refer to Map A.

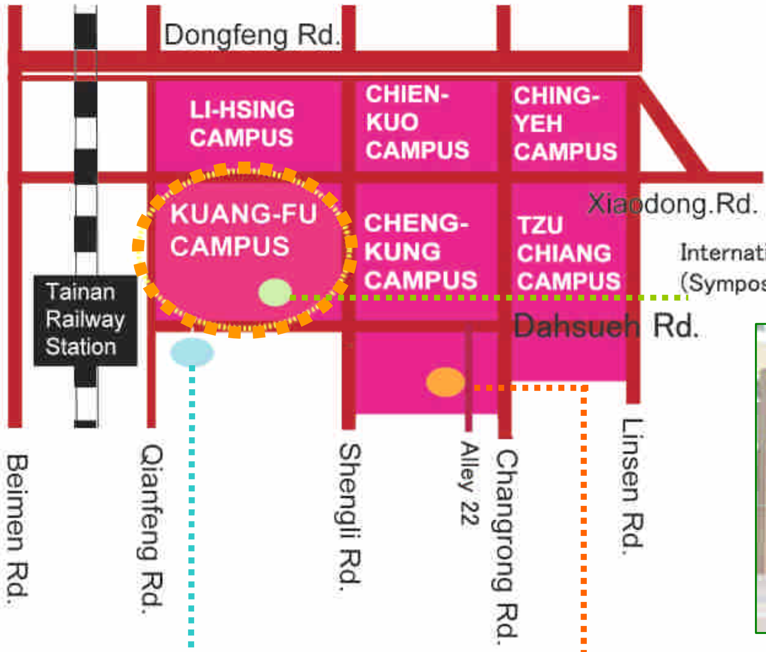
Farewell Party

The farewell party will be held at the Tayih Landis Hotel at 18:30 on day 2 of the symposium, November 3. This hotel is prestigiously located in the bustling new West Gate commercial area. It is conveniently located near Tainan's major historic landmarks, including the Confucius Temple and the Chihkan Towers. Transportation will be provided for attendants who do not drive. For those who drive, please refer to Map B.

Luncheon

On symposium days 1 and 2, buffet lunch will take place at Shangri-La's Far Eastern Plaza Hotel at 11:50, Tainan. The hotel is just a 3-minute walk from the symposium venue. Please refer to Map A. Lunch tickets are attached to your name card.

Map A



International Conference Center
(Symposium Venue)

Shangri-La's Far Eastern Plaza Hotel Tainan
84 Dahsueh (University) Rd.
(for lunch : 11:50-13:30, Nov. 2-3, 2009)

Corner Steak House
12 Dahsueh (University) Rd., Alley 22
(for Welcome Party : 18:30, Nov. 2, 2009)

Map B

Tayih Landis Hotel

660, Sec 1, Shi Men Rd., Tainan, Taiwan

(for Farewell Party: 18:30, Nov. 3, 2009)

Tel: (886-6) 213-5555

TOUR SPOT INFORMATION

Architecture and Building Research Institute, Ministry of the Interior

The Architecture and Building Research Institute (ABRI) is a leading national research agency in Taiwan under the supervision of the Ministry of the Interior. Equipped with advanced laboratory facilities and high-quality research personnel, the ABRI aims to promote innovation and progress in architecture through nationwide research projects, policies and programs, to enhance the level of building technology and the quality of the overall infrastructure.

Website:
www.abri.gov.tw/utcPageBox/ENGMAIN.aspx?ddsPageID=ENGHIC

Anping National Historical Park

Anping, formerly known as "Tayouan", (from which the name "Taiwan" is derived), prides itself not only in its ample heritage to which the roots of many Taiwanese can be traced, but also in its relaxed setting; visitors easily find themselves captivated by its enchanting sunset and nightlife, its world class waterfront and delectable local cuisine.

Anping, a famed historical site, is best known for its First-class Anping Fort and Eternal Golden Castle; pay a visit to the German Consulate, Haishan Hostel, former Tait & Co., Dongxing Foreign Company and Anping Artillery Fort, and one would discover well-preserved traditional dwellings hidden in alleyways which, together, tell a story of how Taiwan has traveled through three centuries, from Dutch occupation, through the Ming and Qing Dynasties, to the Japanese Colonial Period.

Anping's value as a tourist destination is harnessed by the government's continual investment in local recreational facilities, including the Lin-Mo-Niang Park and Harborside Historical Park, the Canal Museum and the Anping Oyster Shell Cement Kiln Museum, the Anping Tree House, Chyautou Beach Park, Sunset Platform and the Anping Harbor Trail. Theme parks, namely the Zeelandia Museum, Historical Waterscape Park and the Naval Exhibition Area, are scheduled for completion in the foreseeable future.

Anping is exemplary of how the old and the new can harmoniously coexist. A visit to Anping will indefinitely intensify one's travel experience.

Website:
anping.tncg.gov.tw/home_e.jsp

CIB NEWS ARTICLE

International Council for Research and Innovation in Building and Construction

Providing a global network for international exchange and cooperation in research and innovation in building and construction, in support of an improved building process and of improved performance of the built environment.

November 2008

From the CIB General Secretariat

Fraunhofer Informationszentrum Raum und Bau

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- Conservation
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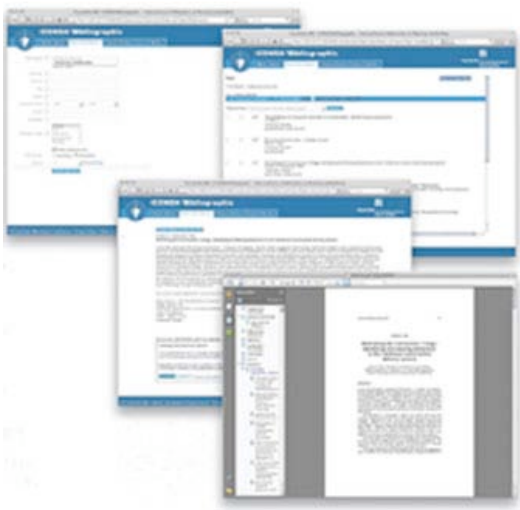
- Green Area Planning
- Building Planning Structural Design
- Civil Engineering
- Water, Soil & Waste Engineering
- Building Industry
- Building Site Operation & Logistics
- Planning & Contract Law
- Town & Regional Planning
- Housing Planning



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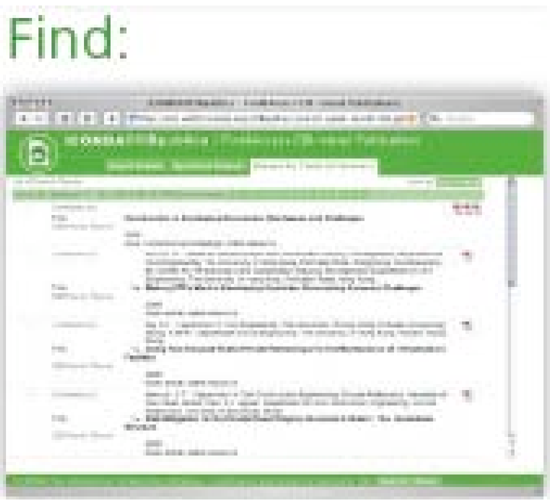
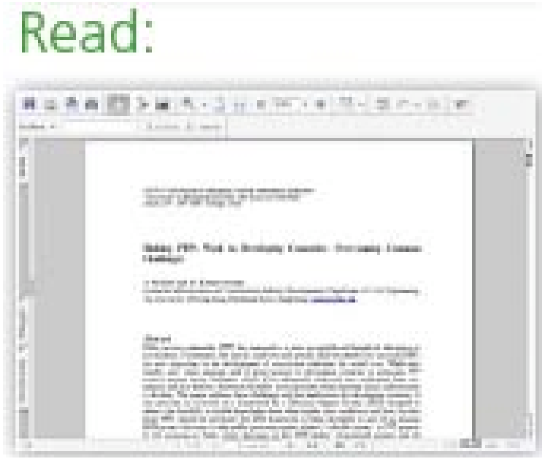
ICONDA®CIBlibrary holds records and associated full text files of monographs (books, reports, proceedings) as well as serial publications (e.g. journals).

ICONDA®CIBlibrary is continuously being loaded with content. This includes uploading current material, e.g. latest conference proceedings, as well as digitalisation and indexing of archival volumes previously available only on paper.



ICONDA®CIBlibrary after its first operative year since its launch, on the occasion of the CIB World Building Congress 2007 in Cape Town, already holds more than 7,000 documents and grows rapidly through the contributions from the various CIB Working Commissions, Task Groups and other sections of the CIB network.



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- National Science Council, Taiwan
- Department of Architecture, National Cheng Kung University

/ Co-sponsors /

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- Construction and Planning Agency, Ministry of the Interior (CPAMI)
- Architectural Institute of the Republic of China

/ Acknowledgments /

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- Architect Yong-Xsin Tzeng
- Architect Shih-Che Yan
- Taiwan Property Management Association (TPMA)