

# Green Construction in Oman: Progress and Implementation Barriers

N. Zainul Abidin<sup>1, a</sup>, A. Powmya<sup>2, b</sup>

<sup>1</sup> School of Housing, Building and Planning, Science University of Malaysia (USM), 11800 Penang, Malaysia

<sup>2</sup> Department of Built Environment Engineering, Muscat College, P.O. Box: 2910 Ruwi, P.C.: 112, Sultanate of Oman

<sup>a</sup>nazirah\_za@usm.my, <sup>b</sup>ayisha@muscatcollege.edu.om

## ABSTRACT

As Oman is facing rapid urbanization and engaging in many ambitious infrastructure projects, the country can no longer ignore the impact of such construction progress to its natural resources and environment quality. The slower pace of construction progress in Oman in the past provides huge opportunity for the green concept to be integrated alongside the growth of the industry, instead of introducing the concept onto a matured one. Although still at the early stages, Oman has taken promising steps towards 'green' direction. In principle, the Sultan has demonstrated a personal commitment to environmental protection, and the country has a sound record of environmental law. Some of the new projects are trying to obtain green certification from LEED. However, green concept is still new to Omani people and as such many initiatives to promote the concept are necessary. This paper explores the green progress in the industry. Through a survey, the barriers for green implementation will be highlighted and discussed. As venturing into green construction would be a maiden experience to many practitioners in Oman, it is expected that this study would shed lights into the current status of green application in the Omani construction practices and enable further recommendations be made to improve and promote wider application in the future.

**KEYWORDS:** Oman, Green Construction and Barriers

## 1. INTRODUCTION

Many Gulf Cooperation Council (GCC) countries have experienced swift booming in construction sector in the past decade resulting in escalation of domestic energy consumption per capita (Al-Hathloul, 2004). However, poor regard to environmental issues has put these countries as among the highest contributor to CO<sup>2</sup> emission per capita (Carbon Dioxide Information Analysis Centre, 2007). There is an apparent lack of emphasis on the concept of sustainable or green in the construction projects in the GCC countries. Many argued that one of the key challenges currently facing the construction industry in the GCC is the need to incorporate green elements in the project (Al-Saleh and Taleb, 2010; Alnaser and Flanagan, 2007; Samarai and Qudah, 2007).

While it's neighboring countries such as U.A.E. and Qatar has been in fifth gear in pursuing development in the last decade, The Sultanate of Oman was not eager to follow. Instead, focus has been to improve the internal affairs of the country such as education and quality of living. Oman has seen a stable growth in terms of health, education and income in the last 40 years (UNDP, 2010). Nonetheless, Oman also realized the need to improve its infrastructures and buildings. The

government has been investing continuously in developing infrastructure all over the Sultanate. Thus, in the last five years, the country has seen a rapid movement in the construction sector.

The concept of green, although has been lauded by many countries, is quite new to GCC countries including Oman. The slower pace of construction progress in Oman provides huge opportunity for the green concept to be integrated alongside the growth of the country, instead of introducing the concept onto a matured one. As a booming country, Oman has many new projects in store. As such, it is pertinent to push the sustainable or green concept as fast as possible into the construction industry to optimize the opportunity of building green for many new projects.

The objectives of this paper are to present the current progress of green construction in Oman and the barriers of implementation. A survey has been conducted to explore the perception of the construction practitioners in Oman regarding the level of knowledge and to understand the major impeding factors of green development. The findings suggest that many more efforts are necessary to push green construction to the forefront and the government should play the major role in this development.

## 2. GREEN PROGRESS IN OMAN

The government of Oman is pushing ahead with large-scale infrastructure projects and focusing on the development of industrial capacity in line with its 'Oman Vision 2020'. In its Eight Five-Year Plan (2011 – 2015), it has allocated US\$ 6.5 billion a year to investment projects, US\$ 1.2 billion to housing, US\$ 4.2 billion to airport expansion and construction, US\$ 3.1 billion to road projects, US\$ 1.3 billion to seaports and US\$ 1.2 billion to the utilities sector (Oxford Business Group, 2012). Some of the ongoing or planned key infrastructure projects in Oman are International Railway Project, Al-Madina A'Zarqa (Blue City), Muscat International Airport, The Wave Muscat, Duqm Development Project, Sohar Industrial Port and Oman Convention and Exhibition Centre (Business Monitor International, 2013). There is an increase of 23% on the government spending in construction industry in 2012 over the corresponding figure for 2011. The allocation for the housing sector have surged 21.5% from RO266 million in 2011 to RO323 million in 2012, including the allocation of housing units for low income citizens (Albawaba Business, 2012).

Intensive development without proper attention to environmental aspects shall spring many environment-related problems as experienced by many countries (Ling and Gunawansa, 2011; Qi et al, 2010; Zainul Abidin, 2010; Majdalani et al, 2006). As Oman is still at early stages of construction booming, the impact related to environmental problem may not be apparent yet but if it continues to ignore the importance of being green, the country shall suffer like others. Currently, Oman faces water scarcity and periodic droughts. Irrigation-intensive agriculture in the most fertile region, the Batinah coast, often leads to the saline intrusion via aquifers (BTI, 2012). Due to the geophysical and climatic setting of the country, 75 % of the country total surface is covered by desert. Thus the remaining land has to be shared for different purposes of the Omani society. While land consumption by residential use, services and transport infrastructure is increasing steadily, suitable land for agriculture is decreasing. This supports rural-to urban migration or transition and thus recreates new demands on shrinking land resources. Urban settlement patterns are created through random additional of freestanding villas on walled plots, consuming high amount of energy for conditioning (Nebel, 2012). Buildings are usually designed by engineer, thus creating stereotype in design, poor design quality and lack of design ingenuity normally found in architecturally-designed buildings. Oman' economy is heavily dependent on oil and gas sectors. However, Oman's oil fields are generally smaller, more widely scattered and pose higher production costs than other Arabian Gulf countries. With the fast growing energy demand in the country, the Government of Oman has beginning to venture into alternative energies which mainly focus on solar and wind projects (Al-Badi et al, 2011). The residential sector is the largest consumer category with its consumption taking more than half of the total system energy (67%) in 2011 (Authority for Electrical Regulation, 2011). As Oman experienced less rain in the past, attention was not given to drainage system. But the change of climate in the last 3

years has seen a more frequent rain which leads to scattered flooding due to poor or no drainage system.

In principle, the Sultan has demonstrated a personal commitment to environmental protection, and the country has a sound record of environmental law, enforced by the Ministry of Environment and Climate Affairs. Environmental concern tends to lose pre-eminence with increasing frequency in the face of private interests and the development of tourism, real estate and industrial projects. Research institutes are still nonexistent and R&D was evaluated at 0.1% of GDP in 2007. The government has started to address this deficiency by creating a Scientific Research Council (established in 2005 by royal decree) (BTI, 2012). The Research Council aims to promote research and innovation to increase the awareness of Omani on the importance of environmental protection, green building and eco-design. One of the way to promote green construction is by introducing Oman Eco house Design competition where Higher Education Institutions competed in designing houses that are innovative in architecture, engineering and inspiration in 2013 (The Research Council, 2013).

Among the Gulf countries, U.A.E has been fast in pursuing green certification. Table 1 list the number of LEED registered and certified projects in GCC countries in 2010. The table shows that Oman has 15 projects registered with LEED but none of the projects has been certified yet. U.A.E and Qatar have introduced local green building assessment to boost the green construction progress locally i.e. The Pearl Rating System (U.A.E.) and Global Sustainability Assessment System (GSAS) (Qatar) (Zafar, 2012). Oman Green Building Council has been newly established in 2012. It is a non-profit non-governmental organisation established with the objective of promoting green building concept and its principles, save the environment and ensuring sustainable development. It has been actively promoting green concept through conferences and seminars.

Table 1. LEED registered and certified projects (Seneviratne, 2010)

Countries	Registered	Certified
Kuwait	3	0
Bahrain	7	0
Saudi Arabia	39	1
U.A.E	517	25
Oman	15	0
Qatar	42	0

### 3. OVERVIEWS ON GREEN CONSTRUCTION BARRIERS

The construction industry as a whole has to rapidly come to terms with the broader environmental and social agenda as the built environment affects all human activity. Bringing change to the construction industry requires multiple efforts from various angles especially to overcome any resistances in the form of technology, human aspects, financial and resources. The transition from conventional to sustainable approach consumes time as it requires changes from different facets in the industry ranging from individual, organizational to industry level.

Green construction is commonly associated with the use of green technology especially to reduce the energy consumption, indoor cooling, water saving, green material etc. However, the use of new technology is perceived as expensive due to the need of technical capacity, lacks competition and commonly manufactured abroad (Robichand and Anantatmula, 2011). The challenge is to produce this technology at the minimal cost possible as building which is too expensive will have marketability problem.

The lack of knowledge, information and understanding are another worrying barrier to the success of delivering sustainable buildings (William and Dair, 2007). The factors that will jumpstart sustainable movement are awareness and knowledge (Zainul Abidin, 2010). It is important for construction practitioners to understand sustainable construction sufficiently to be able to ensure that their actions and decisions add as little as possible to the total burden on the environment.

Commitment of construction organisation will lead to actions that will expedite the move towards sustainable direction. Manly (2004) stated that it is within the professional responsibility of the construction players to show leadership in creating a step for better sustainability in construction. In most cases, the fear of upfront cost is the reason for construction practitioners to ignore the implementation of sustainable design and technology in the construction industry (Sonagar and Fieldson, 2008).

The government is responsible in enforcing better regulation, revising legislation and policy and introducing building codes, regulations, voluntary actions, incentives and fiscal instrument (Meacham et. al., 2005). If the governments are not proactive, the progress of green construction will face many hurdles.

Public awareness is one of the significant factors affecting the lack of responsibility towards nature (Zainul Abidin et. al., 2012). Greater involvement and constructive interaction from the demand side which includes the clients, buyers and users, will inevitably improve good practice initiatives, drawing closer linkages to the supply side and consequently in the delivery of improved sustainable construction.

## **4. FIELD STUDY AND FINDINGS**

### *4.1 Research methodology*

The concept of green construction is new to the country but Oman has initiated several efforts to push the concept into the construction industry. To understand how far this concept has penetrated the industry, a survey was conducted among construction practitioners in Oman focusing on the current progress and barriers of implementation from the practitioners' point of view. The questionnaire was first distributed via post and email. However, due to very poor response, a snowball sampling style is later adapted to gain more response as it enables prior interactions with respondents. A total of 67 questionnaires were returned for analysis. The data gathered was analysed qualitatively (open-ended questions) and quantitatively (scale-typed questions). The results are discussed next.

A total of 67 construction practitioners have responded to this survey. Majority of the respondents are from contractors company (47.8%), followed by developers (17.9%), engineering consultants (16.4%), university and government sector (16.4%) and lastly architectural firms (1.5%). A total of 50.8% respondents have more than 10 years experience working in the construction industry and another 32.8% have work experience between 5 to 10 years. Their range of project profiles varies from individual villas to commercial buildings, governmental offices and infrastructures projects.

### *4.2 Overview of current progress*

To overview the current progress based on the perception of the construction practitioners, the respondents were asked 3 straightforward questions: level of environmental consideration in Oman's construction industry; government actions to ensure construction projects protects the environment; and the level of knowledge of construction practitioners on environmental issues. The respondents were asked to provide their answer in the scale of 1 (very poor) – 5 (excellent).

From the survey, no respondent believes that the environmental consideration in Oman construction industry is 'excellent'. Majority of the respondents (40%) rated the consideration as 'moderate' followed by 'poor' level (25%). Around 19% respondents rated the performance as 'good' while 15% rated it as 'very poor'. The average mean is 2.66, placing the consideration between poor to moderate level. Majority of respondents (40%) also rated the level of actions by the Omani government to ensure the construction projects protects the environment as 'moderate' and followed by those who ranked it as 'good' (30%). A total of 9% respondents believed that the action by Omani government is 'excellent' and another 4% ranked is as 'very poor'. The remaining 16% chose 'poor' level. The average mean is 3.16, placing the consideration at moderate level. For the third question, majority of the respondents (43%) also perceived that the level of knowledge of construction

practitioners in Oman on environmental practices a 'moderate'. Another 30% respondents viewed it as 'poor' while another 9% as 'very poor'. The remaining 18% perceived it as 'good'. The average mean is 2.72%, in line with the respondents' view on the level of environmental consideration in Oman construction industry.

From the survey, generally, the progress of Oman construction industry is perceived as between 'very poor' to 'moderate'. Several challenges that contributed to this situation are discussed next.

#### 4.3 Barriers of green construction

A total of 12 barriers have been identified as potential barriers to effective implementation of green construction. Each impending factors can be rated in a scale between 'very low' (1) to 'very high' (5). Further support to this findings were available through open-ended question while enable the respondents to express their opinion on the matter. The result from the survey is summarized in Table 2. Apart from barrier no. 1, all other barriers are within 3.0 to 4.0 in average mean ('moderate' level). Barriers no. 2 to 10 is above 3.5 while the last 2 barriers are lower than 3.5.

Table 2. Barriers for green construction in Oman

Barriers	Average Mean	Rank
Lack of understanding of this concept	3.81	6
Lack of demand for green construction	4.10	1
No local green certification available	3.78	8
Lack of locally produced green products	3.64	9
Lack of promotion for sustainable projects	3.79	7
Resistance to change in current practice	3.63	10
Believe that green construction is not important	3.31	12
Believe that cost of construction will be more	3.85	4
Lack of initiative by government / professional bodies	3.82	5
Lack of pressure by the government	3.96	2
Lack of incentives from the government	3.91	3
No culture for green construction	3.46	11

- a) *Lack of demand for green construction* – This barrier is ranked as no. 1 in the list with the average mean of 4.10. A total of 46% respondents perceived this factor poses 'high' level of problem followed by 33% at 'very high' level. Some respondents stated that people are indirectly aware on this issue but there is very poor demand for green construction in the market either from public sector or private sector. A few respondents argued that the lack of awareness among the construction practitioners contributed to the poor demand for this concept. One respondent stated that the lack of demand is because it depends on individual effort and currently there is no interest to pursue it. A few respondents stated that the initiation from the authorities did not reach the greater population of construction practitioners.
- b) *Lack of pressure by the government* – Many respondents believed that the government should play a bigger role in promoting green construction, through actions such as through strong enforcement of legislation, devising new policy, or demanding green concept in their new governmental buildings. As shown in Table 2, the average mean is 3.96, placing this barrier as no. 2. A total of 52% respondents perceived this factor poses 'high' level of problem followed by 24% at 'very high' level. Many respondents stated that there is no pressure from the authorities to do green buildings even for governmental projects. Aspects of environmental issues have been initiated for a few major projects. However, the initiations were mostly from the private sector.
- c) *Lack of incentive by the government* – Many respondents argued that the lack of pressure by the government is related to the poor incentives introduced by the government to the construction practitioners who want to pursue green in their projects. The average mean is 3.91. A total of 40% respondents perceived this problem as 'high', followed by 30% who perceived it as

- ‘moderate’. One respondent stated that having government LEED building projects will help propagate green architecture in Oman. Active involvement from the government will enable them to see what sorts of incentive they can offer to the industry to boost up green construction.
- d) *Believe that cost of construction will be more* – This fourth barrier has an average mean of 3.85. Majority respondents (48%) perceived this problem as high followed by 31% who rated it as moderate. Another 19% rated it as ‘very high’. Many respondents believed that green construction is economically non-viable. It increases project cost, thus making it non-attractive. One respondent stated that incentive from the government can help to reduce the increment in construction cost. Another respondent argued why the cost will be more is because of the lack of basic infrastructure such as recycling centre, public transport network and easy access which will prohibit the achievement of good environmental standards in the country and increases the cost for the project if the basic infrastructure is to be added to the project cost.
- e) *Lack of initiative by the government/ professional bodies* – respondents argued that the government has been supportive to the actions by the private sectors that are pursuing green certification and has been involved in collaborative efforts with professional bodies in organizing conferences and seminars on green construction. However, those efforts have limited impact as only those who have been involved or planning to involve with green projects are participating in it. Another respondent argued that it is crucial that government commitment for green construction is made clear to all construction practitioners. At present, the government desire for green construction is not clear. The average mean is 3.82. A total of 46% respondents perceived this problem as ‘high’, followed by 31% who perceived it as ‘moderate’. Another 19% perceived the barrier as ‘very high’.
- f) *Lack of understanding of green concept* – This barrier is ranked as no. 6 in the list with the average mean of 3.81. A total of 54% respondents perceived this factor poses ‘high’ level of problem. This is followed by 22% respondents perceiving the problem as ‘moderate’ and another 16% as ‘very high’ level. One respondent stated that green architecture is making a push into the country, but as many do not understand what it entails, the acceptance has been affected. Another respondent argued that it is a common practice in Oman that civil engineers are taking on the work of an architect such as designing the building. Without good designing background, these engineers are unable to provide advice to the clients on eco-friendly architecture as they themselves are not knowledgeable on the subject. As such, not only the building is not ‘green’ in design, the quality of the finished product is also of lower standard as compared to other developed countries.
- g) *Lack of promotion for sustainable projects* – This barrier is ranked as no. 7 in the list with the average mean of 3.79. A total of 39% respondents perceived this factor poses ‘high’ level of problem. This is followed by 34% respondents perceiving the problem as ‘moderate’. It is difficult to promote sustainable projects when the number of such projects is very few. Currently, only 15 projects have registered with LEED but none of those projects has been certified yet. The progress of these projects, however, has been informed through newspapers and national conferences.
- h) *No local green certification available* – The average mean is 3.78 (no. 8). Majority respondents (40%) perceived this factor poses ‘moderate’ level of problem. This is followed by 33% respondents perceiving the problem as ‘high’. A few respondents argued that although there is no local green certification available, the construction practitioners can always opt for other countries green assessment system such as LEED. However, other respondents also argued that having local green certification will speed up the green progress in the country as it will cater for the need of the local such as Pearl Rating System in U.A.E. One respondent stated that LEED certification is based on American standard which has different climate than Oman, thus Oman should establish its own rating system.
- i) *Lack of locally-produced green products* – The average mean is 3.64 (no. 9). Majority respondents (39%) perceived this factor poses ‘moderate’ level of problem. This is followed closely by 37% respondents perceiving the problem as ‘high’. One respondent stated that research and development (R&D) culture is not yet present in Oman. As such, the growth of

high-tech locally-made product is very slow. Another respondent stated that the poor demand for green construction also discourages the introduction of local green products.

- j) *Resistance to change in current practice* – This is barrier no. 10 with average mean of 3.63. Majority respondents (40%) perceived this factor poses ‘moderate’ level of problem. This is followed closely by 28% respondents perceiving the problem as ‘high’. One respondent stated that it is difficult to change the mindset of the construction practitioners as there is no clear support from the government and no apparent demand from the society. Another respondent stated that lack of knowledge for this subject is another hurdle that contributes to the resistance for change. Other respondent stated that green movement usually come from the rise in cost of energy, as this factor is not critical in Oman, they are not desperate to change their way of life or work pace.
- k) *No culture for green construction* – This is the second lowest barrier with the average mean of 3.46. Majority respondents (36%) perceived this factor poses ‘moderate’ level of problem. This is followed by 33% respondents perceiving the problem as ‘high’. According to a respondent, traditional way of building houses has incorporated many eco-friendly functions to reduce indoor heat by having small openings, courtyard, maximize natural ventilation. But with the fast growth of the residential industry and because many builders in Oman do not have qualified architects, the task of building design is taken over by civil engineers who can build structure to serve as building but lack of knowledge on ways to make a building eco-friendly.
- l) *Believe that green construction is not important* – This is the lowest barrier with the average mean of 3.31. Majority respondents (40%) perceived this factor poses ‘high’ level of problem. This is followed by 34% respondents perceiving the problem as ‘moderate’. Another 12% perceived the issue is ‘low’ and 6% perceived as ‘very low’. The remaining 7% selected ‘very high’. It seems that respondents are generally aware that green construction is important, placing this factor as the least aspect to worry about.

## 5. CONCLUSIONS

The push towards green construction is relatively new in Oman, but actions have been initiated by several parties to bring this concept to the forefront of the country agenda at par with other developing countries. In a nutshell, the progress of green construction is still at initiation stage. There are many aspects that needs further improvement such as governmental participation and involvement, professional bodies proactive movement, introduction of local rating system, changing the primary task of design from engineers to architects, raising more awareness and knowledge on the subject and many more

## REFERENCES

- Al Hathloul, S., 2004. “Planning in the Middle East: Moving towards the future.” *Habitat International*, 28, pp. 641 – 643.
- Al Saleh Y.M., and Taleb H.M., 2010. “The integration of sustainability within value management practices: A study of experienced value managers in the GCC Countries.” *Project Management Journal*, 41 (2), pp. 50 – 59.
- Al-Badi A.H., Malik, A., and Gastli, A., 2011. “Sustainable energy usage in Oman – opportunities and barriers.” *Renewable and Sustainable Energy Reviews*, 15, pp. 3780 – 3788
- Albawaba Business, 2012. “Oman: Government Spending in Construction Industry to Jump 23%.” Retrieved: 19/5/2013. <http://www.albawaba.com/govt-spending-construction-industry-jump-23-10b-411055>
- Alnaser, N.W., and Flanagan, R., 2007. “The need of sustainable building construction in the Kingdom of Bahrain.” *Building and Environment*, 42 (1), pp. 495 – 506.
- Authority for Electricity Regulation, 2011. “Annual Report 2011.” Oman. Retrieved: 5/8/2013. <http://www.aer-oman.org>

- Business Monitor International, 2013. "Oman Infrastructure Report Q2 2013." Retrieved: 18/5/2013. [http://www://fastmr.com/prod/584538\\_oman\\_infrastructure\\_report\\_q2\\_2013.aspx](http://www.fastmr.com/prod/584538_oman_infrastructure_report_q2_2013.aspx)
- BTI, 2012. "Oman country report." Retrieved: 7/11/2012. <http://www.bti-project.de/fileadmin/Inhalte/reports/2012/pdf/BT%202012%20Oman.pdf>
- Carbon Dioxide Information Analysis Centre, 2007. "Ranking of the World's Countries by 2020: Total CO<sup>2</sup> emission." Retrieved: 5/12/2012. <http://www.cdiac.ornl.gov>
- Ling F.Y.Y, and Gunawansa A., 2011. "Strategies for potential owners in Singapore to own environmentally sustainable homes." *Engineering, Construction and Architectural Management*, 18 (6), pp. 579-594
- Majdalani, Z., Ajam, M. and Mezher, T., 2006. "Sustainability in the construction industry: A Lebanese case study." *Construction Innovation*, 6, pp. 33 – 46.
- Manly, G., 2004. "Creating a Step Change for Sustainable Construction." CIBSE National Conference on Delivering Sustainable Construction. London, 29 – 30 Sept.
- Meacham, B., Bowen, R., Traw, J., and Moore, A., 2005. "Performance-based building regulation: current situation and future needs." *Building Research & Information*. 33, pp. 91- 106
- Nebel, S., 2013. "Towards sustainable patterns of urbanisation in Oman." Retrieved: 6/5/2013. <http://www.gutech.edu.om>
- Oxford Business Group, 2012. "The Report: Oman 2012." Retrieved: 1/8/2013. <http://www.oxfordbusinessgroup.com/country/oman>
- Qi G.Y., Shen L.Y., Zeng S.X., and Jorje O.J., 2010. "The drivers for contractors' green innovation: An industry perspective." *Journal of Cleaner Production*, 18, pp. 1358 – 1365
- Robichand, L.B. and Anantamula, V.S., 2011. "Greening project management practices for sustainable construction." *Journal of Management in Engineering*, pp. 48 - 57
- Samarai, M., and Qudah, L.M., 2007. "Planning sustainable mega projects in UAE." *World Housing Congress 2007: Affordable Quality Housing*, Terengganu, Malaysia.
- Senerivatne, M., 2010. "Green buildings in the GCC countries." Presented in *Development of Economic and Innovation*, Montreal, Canada
- Sonagar, B. and Fieldson, R., 2008. "Towards a sustainable construction practices." *Construction Information Quarterly*. 10, pp.101 – 108
- The Research Council, 2013. "Oman eco house design competition." Retrieved: 23/4/2013. <http://home.trc.gov.om/tabid/402/language/en-US/Default.aspx>
- United Nation Development Programme (UNDP), 2010. "Five Arab States among top leaders in long-term development gains." *Human Development Reports 2010*, Retrieved: 5/11/2012. <http://www.hdr.undp.org/en/mediacentre/news/announcements/title,21573,en.html>
- William, K. and Dair, C., 2007. "What is stopping sustainable building in England? Barriers experienced by stakeholders in delivering sustainable development." *Sustainable Development*, 15, pp.135 – 147
- Zafar, .S., 2012. "Echoing sustainability in MENA." *EcoMENA*. Retrieved: 5/8/2013. <http://www.ecomena.org>
- Zainul Abidin, N., 2010. "Investigating the awareness and application of sustainable construction concept by Malaysian developers." *Habitat International*, 34(4), pp. 421 – 426
- Zainul Abidin, N., Yusof, N., and Awang, H., 2012. "A foresight into green housing industry in Malaysia." In *Proceeding of World of Science, Engineering and Technology: International Conference of Housing and Urban Environments*. Stockholm, Issue 66, July 2012, pp. 465-473