WASTE MANAGEMENT IN THE CONSTRUCTION INDUSTRY

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Abstract

A detailed study of the application of waste management to a single multi-million dollar residential project in Queensland is described. The study incorporates the assessment of a current on-site waste management operations plan and a questionnaire survey of the construction workers involved to ascertain their involvement and attitude towards the processes.

Keywords: Landfill, recycle, reuse, waste disposal, waste management.

1 Introduction

It is estimated that 13-30% of all solid waste deposited in landfills worldwide comprises construction and demolition waste[l] with a 1:2 ratio of construction to demolition waste[2]. In Holland, for example, this amounts to around 4.25 thousand million tonnes of construction waste each year. Insights into the causes of the generation of waste in construction projects are growing however[1][3] and waste management policies have been developed in Europe for example [4]. In response to increasing awareness of the environment, the Australian Government has established several strategies to implement ecologically sustainable development (ESD). One major arm of ESD is the National Waste Minimisation Strategy, which has set a target of a 50% reduction in waste, 15 % of which is from building and demolition work, going to landfill by the year 2000 based on 1991 standards.

This shift in social attitudes towards 'environmentally friendly' values together with the possibility of future state and local government legislation or taxation on the lines of the UK Landfill Tax[5] suggests that strict guidelines for commercial ventures will soon be introduced. In October 1997, the Queensland Government produced Proposed Waste Management Legislation Public Consultation Documents. As a result, it is becoming necessary for organisations to establish some form of environmental management system. Previous studies in this field suggest that high rates of success may be obtained by implementing waste management strategies in the construction industry. Other defined benefits include financial gains, through the sale of salvaged products or reduced disposal

costs, and environmental benefits[5][6][7][8].

This paper reports an investigation of the current Waste Management Strategy implemented by a major Australian contractor (1) to determine the efficacy of the strategies in use, and (2) to evaluate the practicality and desirability of further developments.

2 Casestudy

2.1 The project

The researchers studied the waste management methods employed by a major Australian construction company and their operation on one construction project in the Brisbane area of Queensland. The project was a Brisbane inner city apartment project, completed in October 1996. Access to the site did not present any problems for coordinating through traffic, as the site was located at the end of the local traffic area. The construction works consisted of two (2) residential towers of five (5) stories each featuring high quality apartments, underground car parking and landscaped surrounds. A permanent crane established centrally serviced both towers. Throughout the site were designated lay-down areas for the storage of goods, site accommodation and waste bins as required.

The project served the purpose of being a pilot project for the contractor in regards to waste management. It was intended to provide a comprehensive trial of waste management procedures and did so successfully. There were several features of note: no previous data or information was available to draw on; personnel were unaccustomed to waste management procedures; there were restrictions on labour availability and time; and there was no material hoist on-site which limited the capacity of handling segregated waste containers. In addition, the contractor had already commissioned and received a consultant report for a Waste Management Strategy for a recent brewery project and the principles noted in this report were also implemented on the case study project. These issues concerned: bin positioning, use and identification; the workers induction program; the provision of a list of local recyclers; and the collection of statistical information.

The contractor drafted a Waste Management Plan (WMP) clearly defining its policy, staff responsibilities and procedures to be adopted and designed to meet and exceed the company's current obligations under the Environmental Protection Act 1994. Although some guidance was provided to develop ways in which to avoid or minimise waste, no specific guidelines were established in work process optimisation, material planning, on-site training and methods of effective and efficient reporting of waste quantities.

The Project Manager correlated the trades represented on the program with the major waste streams, to establish which products presented an opportunity to recycle. Anticipated wastes suitable for recycling included concrete, masonry, timber, metals, and plasterboard. Other waste not suitable for recycling and disposed of as general waste incurred normal disposal charges. In the event that any unacceptable contamination of waste occurred, and disposal at the Brisbane City Council transfer station was required, an additional charge of $55 per tonne was incurred. Hence, handling methods were considered crucial to the effective disposal of waste with the aim of maximising recycling to benefit the environment and reducing disposal costs.

2.2 The waste contractor

A specialist waste transportation firm was commissioned for this project. On this project the specialist's primary responsibilities included the provision of waste collection bins and labelling of the bins to suit the waste streams identified in the contractor's WMP.

Early negotiations with the specialist enabled the planning of suitable methods of disposal of various waste streams and allowed the setting of a fee scale depending on the items removed. The contractor's WMP stipulated that waste material could become the property of the waste removal contractor on collection from site, and that any rebates paid on recyclable products should be made to the account of the waste removal contractor.

The task of monitoring was delegated to the specialist waste handler and included data collection and the subsequent collation and analysis. The driver of the waste bin service truck was responsible for determining where the waste was to be delivered to and whether it was contaminated or not. If the waste was considered to be contaminated the site supervisor was informed and asked to co-sign the delivery docket to indicate agreement that it was contaminated and would be unsuitable for recycling.

At the point of pick up the driver recorded the date, bin size, waste product type and the place of disposal. This method of data collection produced only approximate results. There was concern about the accuracy of data available for this study because of the lack of awareness by drivers of the type of product to be collected and where it was to be disposed.

The waste analysis undertaken by the waste specialist for the contractor provided a month by month breakdown of wastes removed from site and information regarding the specific waste streams targeted for separation and recycling. Calculations were based on weights and provided monthly and cumulative totals and percentage ratios of the respective wastes.

2.3 Site observations

During the course of the project several site visits were conducted during which observations and general conversations with site management were noted. Some of the more important discussions covered waste types, waste handling methods, programming, project types, cost implications, education and human influence on waste management. Observations made in relation to waste management during site visits noted signs and notices, bin contents and waste handling procedures, control issues and site layout.

The waste handling method on-site began at the work area, where wastes were stockpiled and then removed by labourers daily into a small collection bin suspended by the site crane at the edge of the working deck. The crane was used for approximately one hour per day to carry out this clean-up operation. Discussions indicated that this method of waste collection must be analysed closely prior to implementation, to ensure that a particular type of project was compatible with waste handling methods proposed.

Disposal of the four key material types were analysed in detail:

Timber. The majority of timber waste was generated during the formwork process. Primarily, waste occurred from work undertaken on the materials to make them suit the required shape and size of the formed concrete, and due to rough stripping methods. Good planning by the subcontractor to m&e formwork 'fit' with minimal modification and better care during the stripping of formwork would have contributed to reducing

waste. Waste timber products generated by formwork were deposited into bins at the work area since there was easy crane access to place bins onto the working platform. So a high proportion of material could be separated for recycling. Problems included the careless contamination of timber with foreign substances such as masonry or other waste at the ground floor level. The whole load of timber then became non-recyclable and forced the waste contractor to dispose of large quantities of timber waste as general waste.

Masonry and plasterboard. These were used for partitioning works. During construction, a majority of the masonry blocks ordered and used were standard sizes available from the manufacturer, consequently waste was avoided to a large extent. Waste during construction occurred when blocks remaining from various work areas were left over and no effort was made to collect and use them elsewhere. Often these were simply disposed of during clean up. Other minimal waste occurred through broken blocks or due to unusable off-cuts. Plasterboard was susceptible to damage both during handling and also once in place. Planning of sheet sizes required at various stages during the project minimised waste and was carried out by the Project Manager in conjunction with the plasterboard subcontractor and plasterboard manufacturer. Although a bin was provided to receive concrete and masonry waste, no materials of this type were successfully separated. All concrete and masonry waste on this site was disposed of as general waste. Plasterboard waste was collected in stockpiles near the work areas. During the clean up process, the waste was deposited into suspended crane bins as described for metal products. Due to the large volumes of this material segregation was relatively simple. Therefore a substantial amount of plasterboard waste was successfully separated. No recycling opportunities existed for plasterboard on this project, as the manufacturer did not have the facilities to reprocess this product. However, as plasterboard was classified a potentially hazardous waste by the Brisbane City Council and required disposal at special landfill sites, the isolation of this material reduced disposal costs.

Paper Products. A large amount of paper packaging of goods on-site had to be appropriately disposed of. Packaging itself was not significant during the product use phase as it was generally intended for disposal and acted as a protection to goods during handling. Paper products derived from packaging were to be deposited into a bin provided by ***Visy Board*** at the ground floor. Again, sorting difficulties on each floor meant that very little paper products went into the designated bin and were mainly disposed of as general waste.

Metal. Metal waste was mainly derived from reinforcement, steel partition framing and roofmg off-cuts. Reinforcement waste was minimal and primarily resulted from miscellaneous spare items left after the completion of the works. Metal roofing waste was due to off-cuts and modifications made to sheet materials and flashings to suit roof penetrations and geometry. Metal stud waste was attributed to the requirement of size modifications to suit the application. The metal scrap bin was centrally located at the ground floor level between the two apartment buildings. At rubbish collection time, all refuse was collected into one suspended container at each floor level by the crane. Consequently loading work was hurried in order to minimise crane time, and various

waste streams could not be sorted prior to placing in bins. Therefore, only large and easily separable metal waste was placed in the scrap metal waste bin. Valuable waste such as copper and aluminium was retrieved and taken off-site by the subcontractors and did not contribute significantly to metal waste. The remainder was disposed of in the general refuse bin.

Waste types contributing to a majority of the bulk refuse were plasterboard and formwork scrap. When building products were inexpensive, as was the case with plasterboard, little consideration was given to waste minimisation. In the case of formwork, which was not a cheap product and yet still produced high quantities of waste, the reduction of waste required closer supervision.

Human influence on the success of a waste management plan was apparent as it was the work-groups, which had the final control over the waste handling process. The introduction of Waste Management has been viewed in a light similar to Quality Assurance and Workplace He&h and Safety, which are now generally accepted but each required time before becoming completely effective. Generally, people were willing to contribute positively to the environment but it has been difficult to change habits and culture. During discussions with site management, it was mentioned that the younger generation seemed to accept waste minimisation readily whereas the older generation was a little more difficult to convince. Perseverance and continually updated training will, some would hope, influence construction workers positively in due time. Also of influence may be stricter contractual obligations with possible penalty charges for non-compliance. Alternatively, a system promoting a spirit of competition and enthusiasm using incentives may provide the appropriate motivation.

Colour coded notices were placed at various strategic locations on the site including lunchroom walls and the notice boards. However, the effect of waste management notices and signs was lost amongst other general information. Possibly, brighter displays isolated from general news and advertising bulletins may have attracted more attention. The notice itself was clear and easy to understand and should have served as a good reminder of the waste separation requirements established on site. The main waste bins had easily identifiable signs clearly displayed on the appropriate bins at most times. Occasional problems occurred with the correct labelling of the bins as the signs were removable and were shifted around when the bins were picked up by the trucks. All people involved should have taken greater care in handling the bins or depositing waste, to make sure the correct sign was clearly displayed.

Upon examination of the bin contents it became apparent that there was a general disregard for placing the rubbish in the proper bin. General rubbish contained materials that could have been separated with minimal effort. The difficulties of controlling waste segregation at all times became apparent during the distribution of the questionnaires around the site. Work was carried out throughout various areas of the project and workers were difficult to locate. Therefore, it was difficult for one person to oversee the compliance of waste separation and workers' attitudes were such that they could not be relied upon to monitor themselves.

3 Questionnaire survey

The key element in the success of a Waste Management program is the involvement, commitment and perception of construction workers on the project. To determine the influence of the key elements amongst workers, a questionnaire was prepared to obtain their general views regarding the principles of waste management and to obtain background information regarding their knowledge of the process. Seventy seven forms were distributed over the site during two survey periods, and a total of thirty nine were returned, representing a response rate of 51% .

In the staff group analysis, the belief that waste from construction works could affect the environment was generally high across all staff levels. Distinct differences, in the understanding of the waste management processes implemented on this site however, occurred between employees and senior site personnel such as leading hands / foremen and managers. Even though both groups had equal quality training, results showed a higher degree of comprehension among subcontract employees than site management. A conclusion which may be drawn from this is that the lack of interest by leading hands and foremen reflected in their disregard the WMP, as they do not consider it a vital component in producing their work cost effectively.

Analysis of various trade groups showed that a majority of subcontract employees considered that they were supervised for less than 25% of the time. Awareness of environmental issues by major waste producing trades was high indicated by the 85.7% understanding that building waste affects the environment, and a 61.9% belief that waste products from their particular trades could be recycled.

For the major waste producing trade of plasterboard, the education and knowledge segment of the questionnaire indicated only an intermediate level of understanding of the waste management process. This result indicated that the subcontractor's personnel accepted little personal responsibility for waste disposal. Furthermore, a large portion of the plasterboard trade indicated that they had not received any training in waste management. In contrast, a high percentage of the masonry trade indicated that they had an understanding of the waste management process and that it was explained to them. Even though waste generation within the masonry trade was minimised through efficient ordering and material use, the nil success rate indicates that improvements could be made. Perhaps accountability and clean up supervision needs to be upgraded for this trade. Other trades indicated a higher level of understanding of the waste management process. However, the survey showed that part of the plumbing trade group felt that the explanation of the process was not comprehensive enough. Possible explanations for the apparent poor comprehension of the waste management process on this site could be attributed to lack of interest during the site induction, poor recall and low understanding by the workers or because the waste management segment was not presented clearly during the induction process.

Overall, the correlation between the proportion of waste produced by the various trades and the levels of supervision, awareness, knowledge and perception was inconclusive. However, there is some indication that poor results in the plasterboard trade were due to a lack of understanding of the WMP.

The open parts of the questionnaire sought to attract suggestions and comments regarding waste reduction and separation. The results indicate that waste segregation procedures were followed early in the project but that methods became lax as the project proceeded. The comments suggested that to sort rubbish at the point of creation would

require more bins which must be clearly labelled and available on each level. It was suggested that additional time should be allowed for clean up and that clean up supervision should be provided at set times in various areas.

A problem that was envisaged with the method of segregating waste at the point of creation concerned the space needed for the various bins required on the working platform. This suggestion however is debatable as waste stockpiles around the work areas consume space and space requirements for a bin are less than for a stockpile of rubbish of the same volume. Also, mobile bins enable better handling of the waste at clean up time and can be moved if they get in the way of works whereas a stockpile of rubbish requires a somewhat greater effort to be moved.

The facilities indicated as being required included more accessible bins and clearer marking on those receptacles. Also mentioned was the requirement for more effort and common sense by the workers on-site and that this be promoted by additional training.

The question of reducing waste was interpreted in two ways, the waste creation process and the waste disposal process. The waste creation processes highlighted the need for an increase in workmanship skills, tighter ordering procedures and reduced packaging. These were previously mentioned as key factors in reducing waste by prevention. It is obviously an area that subcontractors and manufacturers should address and, if done properly, could have financial benefits.

The waste disposal process indicated the requirement for more accessible bins to assure better waste separation to allow recycling. Also noted was the fact that the subcontractors often took financially viable scrap waste home, which resulted in a reduction in the amount of waste on site but with little value remaining in the segregated products. For example, the contents of the metal scrap bin mainly consisted of scrap steel of minimal value.

4 **Conclusions**

The results of this case study suggest two key criteria, training and process optimisation, for the success of a Waste Management Strategy on a construction site.

Training. Site training of the workers is considered as the key issue to ensure the operation of a successful waste management program on site. The survey of workers indicated that on site training was carried out and a high percentage of the workers understood the procedures. Some indications were given that training in the procedures of waste management were not comprehensive enough and that there may have been a lack of interest during the induction process and that poor comprehension and recall may also have attributed to a lack of commitment to the process. It is suggested, therefore, that training includes a more detailed explanation of the processes during the induction with an emphasis on getting the worker involved in the process and encouraging self monitoring by highlighting the benefits of the program and the way in which the worker can contribute. Finally, to conclude the induction, a worker could be asked to complete a brief questionnaire and sign a declaration of understanding.

Process optimisation. The process of waste handling is seen as a critical issue in that it affects the overall costs of the system and has a large bearing on the success of the program. Costs can be minimised by reducing handling time and labour, and the best

way in which to achieve this has been determined to be waste separation at the point of creation. Although training can encourage participation by the workers in the program, site facilities must be provided to ensure success and the site itself must be suitable for the program. To facilitate the best results bins should be placed near the work areas and should be suitably tagged. Workers then have the opportunity to place waste directly into bins thereby eliminating the need for a labourer to carry out this work. The resulting reduction in waste handling, time and effort as well as encouraging workers to keep a cleaner and safer work environment should lower costs. To facilitate this outcome the waste coordinator should conduct an analysis of the site conditions and the wastes derived to determine the most appropriate methods.

A program forecasting waste streams should be developed by the waste coordinator. This forecast will enable the arrangement of a suitable waste handler and the appropriate main waste bins. Where no waste recycling facilities exist, waste should be deposited into general waste bins.

To monitor the progress of waste management on-site data should be collected regarding the waste types and quantities removed from the site. Thus, the early detection of any problem areas can be identified and the dependence upon data from the waste contractor reduced. This data can then be analysed by site administrative personnel as shown in previous sections of this report.

Waste avoidance and reduction were identified as the most beneficial methods of waste management on a construction site. Waste management requires the cooperation of the builder and the subcontractor to plan material requirements and allow adequate and safe material handling and storage on-site.

5 References

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