MATERIALS WASTE IN THE
EGYPTIAN CONSTRUCTION INDUSTRY

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ABSTRACT

This paper addresses the incidence of material waste in the Egyptian Construction Industry. Construction material waste has proved to have a negative effect on the national economy and the environment. To evaluate the current practices, an in-depth study aiming to identify and quantify waste generation rates and their causes was conducted.

A waste diagnostic survey was carried out on a sample of 35 top contractors. The contractors' selection was based on their size of capital and experience according to the classification of the Egyptian Union for Building and Construction Contractors.

The survey focused on the waste rates and causes of the most dominant materials influencing the projects' costs. The study indicated that among the most fundamental causes of material waste were "Late information", and "Changes to design". A comparison between the local materials waste values in the Egyptian Industry and recently published international values was also carried out.

This article is part of a Ph.D. thesis currently underway by the first author and supervised by the other two authors.

KEY WORDS

Materials wastes, waste rates, dominant causes ,construction industry

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INTRODUCTION

Construction is a key sector of the Egyptian national economy that faces contingent problems regarding wastes in the building materials. Part of the problem stems from the long-held perception among contractors that waste "whenever found" is not considered valueless as long as the contractor can sell it to waste dealers for any cost (not comparable to the original cost) at the end of the job.

Very few data from previous projects are available within the reach of project managers to avoid the causes of waste generated during construction operations. Site visits, interviews, and literature search – related to the construction industry - revealed that few-documented database from previous projects is available.

It is the aim of this article to identify the local materials waste values in the Egyptian Construction Industry. Dominant local causes of materials generation will also be identified according to the Egyptian current practices.

LITERATURE REVIEW

In defining "Lean Production" principles , (Koskela 1992) defined waste as "any inefficiency that results in the use of equipment, materials, labor or capital in larger quantities than those considered as necessary in the production of a building." (Formoso et al. 1999), also defined waste as "any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client". "Waste can be classified into unavoidable waste (or natural waste), in which the investment necessary to its reduction is higher than the economy produced, and avoidable waste, when the cost of waste is significantly higher than the cost to prevent it. The percentage of unavoidable waste in each process depends on the company and on the particular site, since it is related to the level of technological development" (Formoso et al 1999).

The current study follows the same definition of waste presented by (Koskela 1992, and Formoso et al. 1999). This definition of waste is used as a basis to introduce the "Lean Construction" approach on sites, through which non-value adding activities associated with material waste generation are eliminated.

FIELD SURVEY

In order to diagnose the nature of the Egyptian Construction Industry, several interviews were carried out on various on-going field projects for the sample of contractors under study.

The main objective of these preliminary interviews was to pinpoint the most frequent on-site waste categories affecting the final costs of the projects The collected data reflected the projects team members' experiences. Table 1 demonstrates some examples of the waste types that were identified during the interviews. The results of these preliminary interviews showed that "materials waste" were one of the most frequent sources of financial waste, on those sites.

Table 1: Examples of waste types in Construction projects

Material waste due to:
1- Overordering/ excess
2- Overproduction
3- Wrong handling
4- Wrong storage
5- Manufacturing defects
6- Theft or vandalism

Waste in time due to:
7- Idle (waiting periods)
8- Stoppages
9- Clarifications
10- Variation in information
11- Re-work
12- Ineffective work (errors)
13- Interaction between various specialities
14-Delays in plan activities
15-Abnormal wear of Equipment

DATA COLLECTION METHODOLOGY

In order to identify waste categories in construction works, (Alarcon 1994) presented a survey that can be used as a communication tool among site supervisors. The survey aimed to pinpoint the most frequent on-site waste categories, according to the project team members' perceptions and to simultaneously identify the most frequent sources of waste.

Based on Alarcon's previous studies (Alarcon 1994), a survey (questionnaire) was designed concerning material waste identification. The questionnaire that was used as a diagnostic tool was divided into three main sections:

The first section aimed at identifying the most frequent types of projects, the most dominant materials used in these projects, the average percentage of wastes in these materials, as well as the technology used during the execution of these projects. Items of low probability of waste such as elevators, windows, and doors were excluded of the study.

The second section concentrated on the causes of waste generation through categorizing these causes into four categories: a) information, b) management, c) resources, and d) unpredicted situations. Each of these categories allowed the respondents to specify a frequency of occurrence of each specific cause on site (i.e. frequent- sometimes- seldom) compared to the total number of occurrence of all causes. These frequencies were classified

in percentages such as for example: frequent (70-100%), sometimes (40-69%), seldom (0-39%) to help the respondents to give more accurate answers. It should be noted that the percentages of these frequencies were pre-assumed by the authors while designing the questionnaire. This categorization was followed by questions that focused on the attitude and norms of the organization itself to identify the areas with the greatest deficits.

The last part of the questionnaire aimed at identifying the contractor's reliance on a documented database for estimating material wastes from previous projects.

The targeted respondents were a sample of contractors category (A) according to the classification of the Egyptian Union for Building and Construction Contractors (EUBCC). The EUBCC has classified the contractors in the Egyptian Construction Industry into six classes according to their size of capital, years of experience, and some other administrative conditions. The highest class is category (A) with a capital of $ 2.5 million and not less than 10 years of experience in building various kinds of projects in Egypt. Among this category a random sample of 35 contractors were chosen for collecting the data. The criterion of choice was based on the need of a sample of similar contractors with high financial and technological capabilities to be able to undertake future improvement opportunities. Besides, this top category of contractors- whether from the public or private sector - is dominating the building industry market in Egypt.

RESULTS
General Analysis

About 85% (30 contractors) of the sample responded positively to the survey, while the rest either responded negatively or did not respond at all. The answers of the survey were grouped for each type of information separately. The following results were observed:

Materials wastes

The results of answering the questionnaire- by 30 experienced contractors – on the percentages of waste rates during construction operations for specific materials are listed in Table 2. Some contractors did not respond to some questions as they found it irrelevant in their cases. Significant variations in answers were found for some materials such as timber frameworks (2-50%), and sand (2-20%). This may be due to the wide range of performance in terms of materials waste as well as the variance in the applied technology among the sample of contractors. It can also be interpreted as lack of accurate knowledge due to the absence of:

- A waste management plan prior to the execution phase.

- Regular feedback through kept records (database) about waste rates and their causes from previous projects.

This variation indicates the possibility of improving a wide range of areas from internal organizational systems to the execution phase of the project.

The mean (average) rates of waste for some specific materials are presented in a histogram Fig 1. Timber frameworks with an average waste of 13% and sand with an average 9% showed the highest percentages of waste among all materials. While other materials such as reinforcing steel with an average 5%, cement 5%, and concrete 4% were within the acceptable rates: 7% steel, 5% cement (Risk et al. 1998). Tiles and Masonry wastes varied according to their types, which prevent the generalization of presented figures for all types.

Dominant causes of waste generation

Fig 2 summarizes the answers to the most dominant causes of waste generation in the Egyptian industry. The frequencies of this diagram refer to the number of answers that classified the cause as being one of the three categories: a) frequent, b) sometimes, and c) seldom. The study revealed that the most dominant causes (causes of almost 20 % and more reported answers of frequent occurrence) are:

- Late information
- Uncompleted design
- Inadequate information
- Poor control
- Unnecessary people moves
- Untrained labor
- Work not done
- Poor technology of equipment
- Changes to design
- Damage during transportation

Comparison With International Data

A comparison between the current study and other studies developed on work in Brazil and the Netherlands is presented in Table 3. Three studies were conducted in Brazil: a study by (Pinto 1989, cited in Soibleman et al. 1994), a synthesis of the results obtained in five construction sites researched by (Soibleman et al. 1994), and results of experimental studies described by Pinto and Agopayan (1994). The research project from the Netherlands was carried out by (Bossink et al. 1996). Despite the difference in construction techniques, culture, and work procedures between the countries under study, it was found useful to present the absolute results of these studies together to get a better feeling of the gathered data. It should be noted that the results of the current study represent the experts' opinion, where data from other studies might have included site-measured data.

The average percentages of material waste in Egypt for concrete, masonry and tiles almost agree with those of recent international studies. A considerable difference between the values regarding reinforcing steel, and cement is recorded. Reinforcing steel showed an average waste of 5% in Egypt compared to an average of 21% in Brazil. This may be due to the fact that, reinforcing steel is one of the highest costing items in the contractors' bill of quantity resulting in greater efforts- on the contractors' behalf- to reduce its waste. Similarly, cement showed an acceptable percentage of average waste of 5% , almost the same as the unavoidable permitted rates : 4-5% (El Bakary, A. 1988 and Risk et al. 1998) within all contractors in Egypt . Studies in Brazil, however showed higher rates.

DISCUSSION

This paper summarizes the first part of an on-going research thesis aiming to minimize and control the incidence of material waste from its source. Due to the absence of an accurate database on the rates, and causes of material waste generation in the Egyptian Construction Industry, the authors found it essential to build their research on an in-depth study that would cover the current situation.

The study revealed that the highest waste rates (13% in average) were related to timber frameworks. However, its impact on the environment is less negative than for other materials as it is sold at the end of the project to scrap dealers in lots to be re-used in minor jobs. Steel, and cement waste rates seem to be within the average allowable rates: 7%, 5% respectively. This may be due to their high cost in the bill of quantities that would lead to higher effort from contractors to control their waste. The previous results on cement waste seems to contradict national data on cement consumption, these data suggest that 50 % of cement consumption is unaccounted for. Although some of this consumption may be recorded because of unreported minor projects (such as renovation work, and private minor projects) it is the authors opinion that real waste of cement material in Egypt is way above what this study demonstrated . Although sand showed a high percentage of waste among building materials, its low cost as a raw material would not significantly affect the projects' cost. However, this type of waste actually causes great damage to the environment. These results favorably agree with those of recent similar studies conducted in Netherlands, and Brazil regarding concrete, masonry, and tiles.

Generally, much of the waste in materials seem to occur due to lack of co-ordination between various specialties on site, and changes to design (even if it was due to the clients' requirements) leading to additional cost wastes to the final project. "Uncompleted design", and "Untrained labor" were among the most dominant causes of waste generation. In addition, "Damage during transportation", and "Unnecessary people movements" pinpointed areas of quick improvements. "Ignorance of specifications", "Resource surplus", and theft actions showed minor effect on waste generation rates.

CONCLUSIONS

This article aims to identify the local materials waste values in the Egyptian Construction Industry. Dominant local sources of materials waste and their causes of generation were also compiled according to the Egyptian current practices. A waste survey was carried out on a sample of 35 top contractors representing both the public and private sectors. The study concluded that:

-Enormous variation in answers for some materials such as timber frameworks (2-50%), and sand (2-20%) were presented. This may be due to the wide range of performance in terms of materials waste as well as the variance in the applied technology among the sample of contractors. It can also be interpreted as lack of accurate knowledge due to the absence of:

1. A waste management plan prior to the execution phase.

2. Regular feedback through kept records (database) about waste rates and their causes from previous projects.

-Some materials such as timber frameworks with an average waste of 13% and sand with an average 9% reported the highest percentages of waste .

-"Late information", "Uncompleted design", "Changes to design", and "Untrained labor", were among the most dominant causes of waste generation.

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