

# CAUSES OF BUILDING MATERIAL WASTE IN CONSTRUCTION SITES IN EGYPT

E. N. SHAQOUR<sup>1</sup> and R. T. ALMASHHOUR<sup>2</sup>

## ABSTRACT

Waste management has low priority in construction projects so as thousands of tons of construction wastes polluting cities in Egypt. The amount of building construction waste in the developed countries is different from that of the undeveloped countries. In Egypt, waste management in construction projects has low priority so as thousands of tons of wastes pollute cities. This study aims at identifying causes of waste and their levels in different building materials in the construction industry in Egypt to select suitable strategies for managing and improving construction processes. A questionnaire survey is designed to evaluate fifty two causes of material waste, identified from previous studies and experts' interviews which are classified into four categories. Two hundred and forty respondents are received. Results show that the most common causes of waste in Egypt are selecting contractors with low experience, material damage in construction sites, poor planning and scheduling of the work by contractors, selection of low quality material, poor storages, and poor control on work contractors. The majority of material wastes are produced from bricks, sand, timber panels, cement, tiles, and concrete.

**KEYWORDS:** Waste; Causes; Strategies; Common; Ranking; Construction; Egypt.

## 1- INTRODUCTION

Construction is one of the key sectors in the Egyptian economy<sup>1</sup>. It faces many difficulties such as low productivity, low quality and safety, delays, cost overruns, and waste of material<sup>2</sup>.

Waste of Material resulting from the construction industry is a very important subject in the point view of researchers concerned with the improvement of the construction process. Many researchers focus on the environmental issues related to material resources<sup>3</sup>.

The construction industry causes depletion of raw material and buildings gets demolished during a short lifetime compared with developed countries. Many studies indicate that the magnitude of waste differs between developed and undeveloped nations. The amount of construction solid waste for example during 2010, was about 42 million tons or 44 percent of the solid waste according to Ministry of State for Local Development (MoLD), and was increasing over the last few years. Whereas the corresponding estimation of Egyptian Environmental Affairs Agency (EEAA) is 4 million tons during 2012 which reflects divergence according to different types of solid waste classification and lack of measurement precision<sup>4</sup>.

Although construction waste has a strong negative impact on the efficiency of the industry, the environment, and the economy in general<sup>5</sup>, managing this waste has low priority in construction sites<sup>6</sup>.

In addition, little information is available on the way the waste is being handled. Until the early 1970s, dumping the waste was the common used method and different studies show that the amount and methods of handling construction waste in the under developed countries, such as Egypt, differs from that of the developed countries. Since improving the construction industry, particularly, the environmental issues related to material resources used in the construction processes is a very important subject<sup>3</sup>, therefore, in 1976, the Conservation and Recovery Act was introduced to clear the dump sites in Egypt<sup>3</sup>.

Construction managers in fact cannot identify and quantify the causes that generate material waste at building sites. This study aims at identifying and classifying the causes of wastes in the construction industry in Egypt and evaluate their levels for different building materials, then defining the suitable strategies to prevent, minimize, or reuse these wastes.

## 2- LITERATURE REVIEW

Waste is a world-wide term used in the construction industry and is defined as the inefficient use

1- Lecturer of Architecture Engineering, Faculty of Engineering, Nahda University, Benisuef city, Egypt. [eman.shaqoor@nub.edu.eg](mailto:eman.shaqoor@nub.edu.eg).  
2- Lecturer of Architecture Engineering, Faculty of Engineering, Nahda University, Benisuef city, Egypt. [rashwan.almshhour@nub.edu.eg](mailto:rashwan.almshhour@nub.edu.eg).

of material, equipment, and labor. It could be a result of unnecessary work practices causing a loss of time, money or material, and therefore a cost overrun<sup>8</sup>. It can affect both the efficiency of construction process and environment since it consumes resources<sup>9,10</sup>, and "can be eliminated without reducing customer value" of the product which is here the building<sup>4</sup>.

The Environmental Protection Department (EPD) of Hong Kong defines waste as an unwanted material produced during construction such as over ordered or discarded material. Building material waste is the difference between material delivered to the site and that is used in a proper way<sup>11</sup>.

The Environmental Protection Agency (EPA) of the United States defines the minimization of waste as "any technique or method which reduces the volume or toxicity of a waste that requires disposal<sup>12</sup>".

Among the many strategies used to minimize material waste in construction sites are the prevention or elimination of waste, reusing material, and recycling. The waste management hierarchy starts by the avoidance that achieves the maximum conversion of resources, then reusing, recycling, and finally the disposal<sup>13</sup>. Different studies have tried to classify waste by aspects such as avoidable or unavoidable nature, resources, direct or indirect losses, and by source<sup>14</sup>.

Causes of waste were categorized into the following four groups: design, operational, material handling and procurement. The project design has many factors such as design modification, lack of experience about the product alternatives, complexity of drawings, contract documentation errors, and low quality products. The operational category also has many factors such as human errors and mistakes by tradespersons, the use of inappropriate materials, bad system of communication between consultant and contractor, and malfunctioning of equipment. The category of material has many factors such as damage of material during transportation or operation and theft. The last category of procurement factor is ordering large quantities and ordering errors<sup>8</sup>.

The causes of material waste in Hong Kong are categorized into two groups: site management and delivery of material. A survey indicates that the most important factors causing material waste are lack of a quality management system to minimize waste, poor storage, bad foundation design, poor workmanship, methods of packaging and transport material, and over ordering material<sup>15</sup>.

A survey conducted on Brazilian construction sites found that the causes of material waste are

overproduction, substitution, waiting time, transportation, processing, inventories, movement, production of defective products, and others<sup>14</sup>.

The most important causes of material waste in construction sites in Indonesia are design modifications, the ability of making decisions in a proper time, lack of trade skills, poor coordination, planning, scheduling, and inappropriate construction methods. The most important causes of waste in Australia are design changes, poor design and quality documentation in site, slow revision and slow supply of drawings, and weather conditions<sup>16</sup>.

The causes of material waste in Egypt were classified into two groups; time and material. The principal reasons of material waste are over ordering amounts, overproduction of material, wrong treatment, improper storage, manufacturing flaws, and larceny<sup>17</sup>.

### 3 - DATA COLLECTION AND METHODOLOGY

#### 3 -1-The Outline

In order to evaluate and rank the most significant factors of producing material wastes in construction sites in Egypt, a quantitative study was undertaken to measure the relative importance of these factors. To find the most common causes of material wastes, and to establish relationships among them, it was necessary to conduct a survey<sup>18</sup>. This study applies the engineering systems approach principles to reach the objectives as follows:

- 1- Identifying the research problem, the study area, and the objectives. This study is conducted on construction sites in Egypt to analyze the causes of material waste,
- 2- Extracting the causes of material wastes from previous studies and from interviews with a number of expert to define and rank the main causes of material waste in Egypt.
- 3- Defining the required data to reach the study objectives, the sample size, the methods of data collection and analysis,
- 4- Collecting data using a questionnaire.
- 5- Analyzing and evaluating the collected data using Statistical Package for the Social Science (SPSS).

#### 3-2-Survey and Data Collection

This study uses three different types of surveys to collect, evaluate, and analyze data related to material waste causes at construction sites in Egypt.

- 1- The first type is a "desk study" survey of reviewing literature to identify and classify the causes of material waste.
- 2- The second type is a field survey by interviewing people with solid experiences in material

waste management in construction sites to acquire their opinions about dealing with this problem and the design of questionnaire.

3- The third type is a field survey to collect data suitable for evaluating the significant causes identified in the first step and rank them to define the significant causes of material waste in Egypt using a questionnaire form.

### 3 - 3 -The Questionnaire Design

The questionnaire divided, into five sections; these are:

1- The first one is the participant's general information related to work type, company classification, and experience.

2- The second is an evaluation of the problem size in Egyptian construction sites.

3- The third section includes an evaluation of the material waste causes.

4- The fourth contains an evaluation of the quantity of waste in different building materials. In the questionnaire, the researcher will use a close and open-ended- questions form.

5- The last section is an evaluation of the strategies used to manage material waste in Egypt.

### 3 -4 - Classification of the Waste of Material Causes in Egypt

Fifty-two causes of material building wastes in construction sites in Egypt were identified from previous works from the desk study of previous literature. Information about these causes were gathered from the field survey depending on the participant's experiences, and then classified into following four categories:

1- Design and documentation (nine causes).

2- Building materials (procurement, storing, operation, handling, and transporting) (sixteen causes).

3- Site management and quality control (twenty causes).

4- Project participants' communication (seven causes).

### 3 - 5 -The Ranking Process

In order to rank the most influencing causes of material wastes at construction sites in Egypt, the mean score, MS, in Likert's scale for each cause was computed using the formula below<sup>19</sup>:

$$MS = \sum_{i=1}^t = \frac{n \cdot (F_i \times S_i)}{N} \quad (1)$$

Where:

S: is the score given to each cause by the respondents, ranging from 1 to 5;

F: is the frequency of responses rating from 1 to 5 for each cause; and

N: is the number of respondent's giving for the same cause.

The mean score MS is ranging from 1 to 5, that

is  $1 \leq MS \leq 5$ .

Relative Importance Index, RII, given below is used to rank the most influencing causes of material wastes at construction sites in Egypt<sup>20</sup>:

$$RII = \frac{\text{The summation of the total point score}}{5 \times N} \quad (2)$$

The value of RII ranges from 0 to 1, that is  $0 \leq RII \leq 1$ . RII is used because it fits the purpose of comparing risk factors. According to Johnson and LeBreton, "RII aids in finding the contribution a particular variable makes to the prediction of a criterion variable both by itself and in combination with other predictor variables"<sup>21</sup>.

## 4 - RESULTS AND DISCUSSION

### 4 -1- Evaluation of the Problem Size in Egyptian Construction Sites.

According to Blalock, the minimum sample size should be 50<sup>19</sup>. The field survey includes consultant offices and construction sites related to contracting companies in Egypt. The sample size is 240 respondents out of which 38.9% contracting companies and 61.1% engineers from consultants' offices. The results show that the building material waste at construction sites in Egypt is a severe problem as shown in Fig.1.

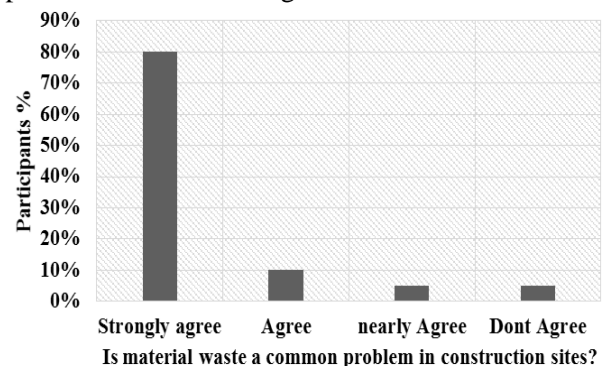


Fig.1- The evaluation of the building material waste problem in Egypt (source: researcher)

The waste reduction techniques is not common in construction sites and only 32% of the companies have a plan to manage material wastes, see Fig.2.

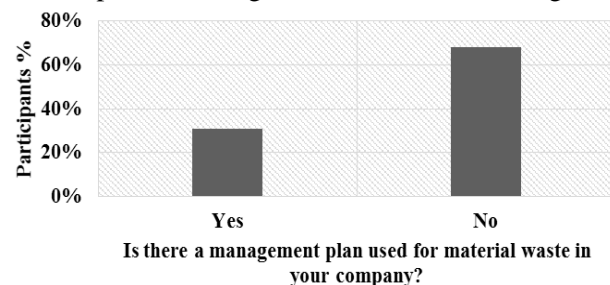


Fig.2- Companies managing material waste at sites in Egypt (source: researcher)

Project Participants focus on completing their projects without cost overrun and according to scheduled time. Waste minimization management

is not considered an important priority as the cost and time. However, results indicate that, 48% of the respondents believe that contractors are the

most willing participants to reduce material wastes in construction sites than the consultants, see Fig.3.

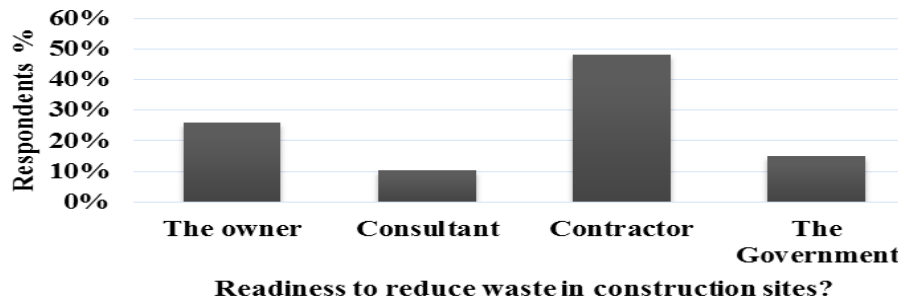


Fig. 3- Participants readiness to minimize waste in construction sites in Egypt (source: researcher)

Project participants ranked according to their responsibility for causing material waste in construction sites. Results show that sub-contractors are the most producing construction material waste in

sites which represented by 63% of the total respondents. The reason mainly seems to be the use of unqualified sub-contractors with low experience, see Fig.4.



Fig.4- The responsibility of causing material waste in construction sites in Egypt (source: researcher)

#### 4-2- Causes of Material Waste in Construction Sites in Egypt

Likert's scale used in order to define the most influential causes of waste in construction sites in Egypt using the sample taken at random from consultants' offices and contracting companies. Five levels specifying the degree of the influence of causes are used. These levels are: very low influence, low influence, medium influence, high influence, and very high influence with scores from one to five respectively. Table (1) represents the result of ranking the levels of influence of factors

causing material waste in construction building sites. The main cause of material construction waste in the selection contractors with low experience, followed by material damage in site, poor planning and scheduling of the work by the contractors, selection of low quality material, poor storages, and poor control on work progress by the contractors. To see the ranking of the fifty two causes see appendix A.

Table 1- Causes ranking according to the influence evaluation. (source: researcher)

The category	Causes of material waste in building sites	The Rank	The mean value	I.I value
Design and documentation	Selecting a contractor with low experience	1	4.5	90%
Building material	Materials damage in site	2	4.39	88%
Site management and quality control	Inadequate planning and scheduling of the workplace by the declarer	3	4.17	83%
Design and documentation	Selecting low quality material	4	4.11	82%
Building material	Poor storages	5	4.11	82%
Site management and quality control	Poor control on work progress by the contractor	6	4.11	82%
Site management and quality control	Lack of strategy of waste minimization	7	4.06	81%
Building material	Changes in materials costs	8	4.00	80%
Site management and quality control	Lack of waste management plan	9	4.00	80%
Building material	Lack of control on site materials	10	3.94	79%
Site management and quality control	Poor equipment	11	3.94	79%
Design and documentation	Unclear, mistakes, and changes in specifications	12	3.89	78%
Building material	Store unnecessary amounts on the site that lead to waste	13	3.89	78%
Building material	Poorly schedule for materials procurement	14	3.83	77%
Building material	Inadequate stacking storage on site	15	3.83	77%
Site management and quality control	Poor workmanship	16	3.72	74%
Site management and quality control	Delays in communicating with the contractor about the material	17	3.67	73%
Project participants communication	Suspension of work by the owner	18	3.67	73%
Design and documentation	Designers do not aware of material types and specifications.	19	3.61	72%
Building material	Waiting for replacing materials that do not meet the specification	20	3.61	72%

### 4 -3-Strategies of Material Waste Management in Construction Sites in Egypt

There are different strategies to manage material waste in sites such as minimization, reuse, recycling, and combinations among them. Minimizing waste is, however, seems to be more logical than reusing or recycling them since it would cost less.

In Egypt, results show that even though construction managers are more likely to minimize wastes they still produce a large amount of solid wastes, see Fig.(5). The concept of waste management still requires more awareness and acceptance in Egypt.

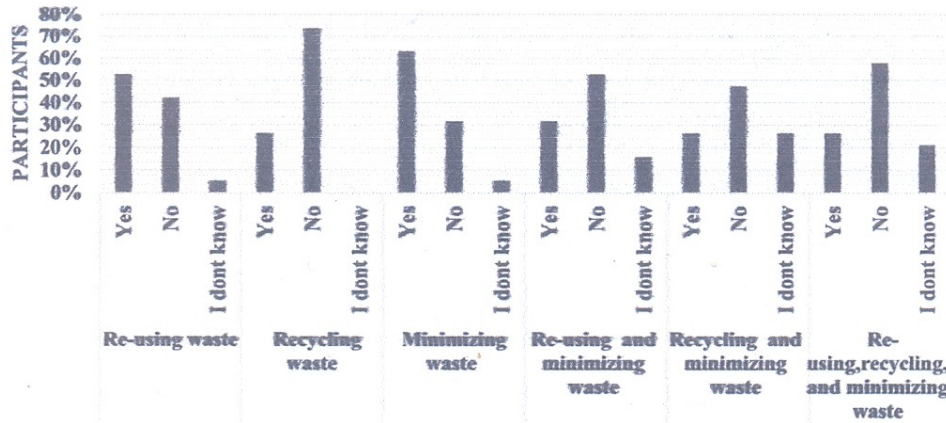


Fig.5- Using of waste management strategies in construction sites in Egypt. (source: researcher)

Results show that both contractors and consultants prefer to minimize wastes rather than recycling it. Contractors are more likely to minimize and reuse

wastes in sites which match the views of consultants; see Fig. (6) and Fig.(7).



Fig.6- Using of waste management strategies by contractors in Egypt (source: researcher)

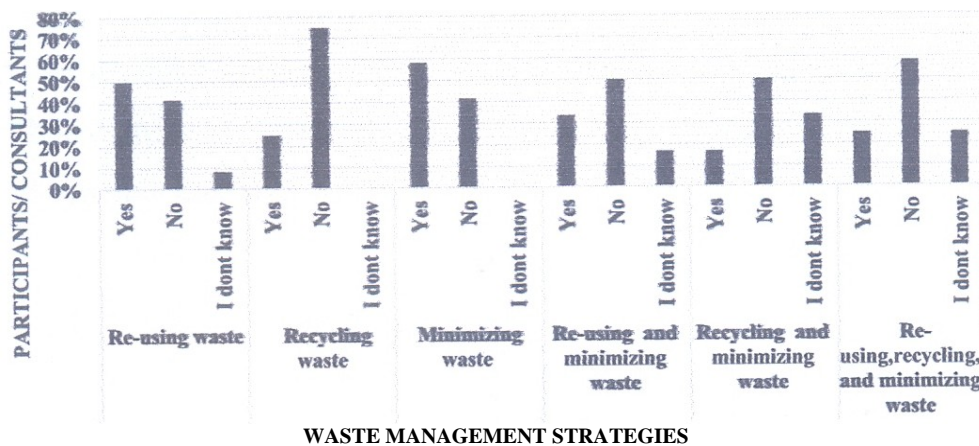


Fig.7- Using of waste management strategies by consultants in Egypt (source: researcher)

According to material type, the use of traditional techniques and traditional building material in construction are the main cause of producing different wastes. Results show that the material

bricks has the largest percentage of waste with 14.49% of the total amount, particularly the damage during delivery, followed by the sand material with 13.39%, then the timber boards used

in formwork with 11.06%, then the cement and concrete resulting from poor formwork with

10.11%, and finally the material glass with 3.83%, see Fig.(8).

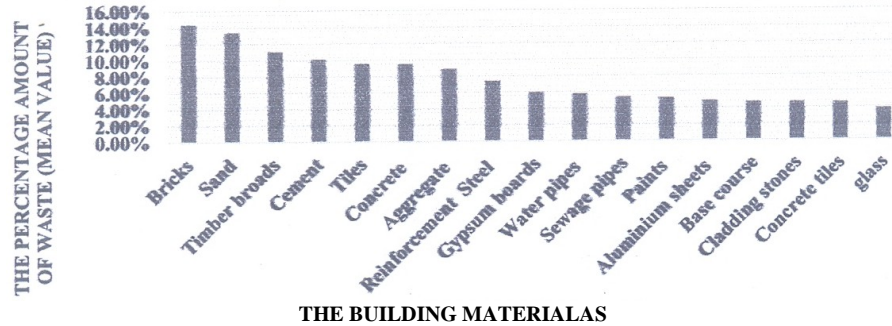


Fig.8- Waste produced from the building material in construction sites in Egypt (source: researcher)

Contractors believe that the material sand has the largest percentage of waste with 12.51% of the total amount, followed by the bricks material with 12.18%, then the timber boards used in formwork with 10.51%, then tiles with 9.26%, and finally the material concrete tiles with 4.25%, see Fig.(9).

Whereas consultants believe that the material bricks has the largest percentage of waste with 15% of the total amount, followed by the material sand with 13.33%, then the material cement with 12.08%, then timber boards with 11.33%, and finally the material glass with 3.42%, see Fig. (10).

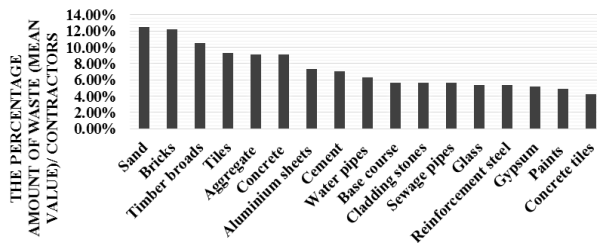


Fig.9- Waste produced from the building material in construction sites in Egypt/ contractors viewpoint (source: researcher)

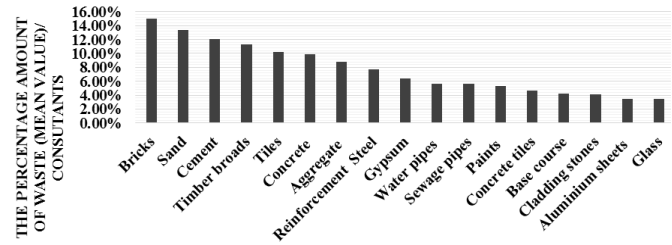


Fig.10- Waste produced from the building material in construction sites in Egypt/ consultants viewpoint (source: researcher)

5- CONCLUSIONS AND RECOMMENDATIONS

LIST OF SYMBOLS

MS	The mean score	MoLD EPD EPA	Ministry of State for Local Development
RII	The relative importance index	MoLD EPD EPA	The Environmental Protection Department
EEAA	Egyptian Environmental Affairs Agency	MoLD EPD EPA	Environmental Protection Agency

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