

# Causes of Time Waste in Construction Projects in Palestine

## مسببات إضاعة الوقت في صناعة الإنشاءات الفلسطينية

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**Abstract:** Waste has been recognized as a major problem in the construction industry in developed and developing countries. It has a considerable impact on the efficiency of the construction industry and the overall economy of the country. Waste in construction is not only focused on the quantity of material waste in construction, but also related to time waste. The aim of this paper is to identify causes of time waste in construction projects and to rank these factors according to their importance from contractors' viewpoint in the Gaza Strip. The research approach adopted in this study was questionnaire survey. 80 valid questionnaires have been studied and analyzed. The results of analyzing 92 causes of time waste considered in this survey indicated that: rework that don't comply with drawings and specifications; lack of materials availability; rework due to workers' mistakes; effects of political and social conditions; and owner's poor communication with the construction parties and government authorities are the most five significant sources of time waste during the construction process. The survey revealed that the site supervisor group is the major cause of time delay. It would be appropriate to arrange formal and informal education and training in time waste management for all concerned parties in the construction industry.

**Keywords:** *time waste, construction, developing countries.*

**المستخلص:** يمثل الفاقد مشكلة كبيرة في صناعة الإنشاءات في الدول النامية ولها تأثير لا يستهان به على كفاءة صناعة الإنشاءات. لا يقتصر الفاقد في الإنشاءات فقط على كمية مخلفات مواد البناء ولكن أيضا يتعلق بإضاعة الوقت. يهدف هذا البحث إلى تحديد المسببات لإضاعة الوقت في مشاريع الإنشاء وتصنيف هذه العوامل حسب الأهمية النسبية من وجهة نظر مقاولي البناء في قطاع غزة. اعتمد البحث على الاستبانة، وقد شملت العينة 80 مقاول حيث تم تحليل 92 مسبب لإضاعة الوقت تم أخذها بعين الاعتبار في الاستبانة، وقد أظهرت النتائج بأن الرسومات والمواصفات وشح مواد البناء المتاحة وإعادة الأعمال بسبب أخطاء العمال وتأثير العوامل السياسية والاجتماعية وضعف التواصل ما بين المالك والأطراف ذات العلاقة بالإنشاء والسلطات المحلية من جهة أخرى هي أهم خمس عوامل لإضاعة الوقت خلال عملية البناء. ولقد أشارت الدراسة الي ان مجموعة الاشراف علي الموقع تعد أهم الأسباب التي تؤدي إلي فقدان الوقت ولذلك فمن المهم تنظيم دورات تدريبية متخصصة لكافة العاملين بمجال الانشاءات في كيفية التعامل مع اسباب إضاعة الوقت.

**كلمات مدخلية:** *إضاعة الوقت، الإنشاءات، الدول النامية.*

## INTRODUCTION

The construction industry is vital for the Palestinian economy and necessary infrastructure development. It is both economically and socially important. The construction sector in Palestine relies on the imports of raw material. However, due to the closures such materials could not be imported, which brought about complete paralysis in this sector, causing delays in housing projects, job losses and high daily sectarian losses (PCHR, 1995). The construction sector is one of the main contributors to the Palestinian economy although it has been one of the hardest hit by the current situation. The sector contributes up to 18% of the GDP, employs approximately 22% of the workforce and absorbs up to 34% of international donor programs (PCU, 2003).

The construction and housing sector is a driving force in the Palestinian economy. The value of its contribution rose from \$410 million in 1994 to \$483 million in 2000. Construction accounted for 12.7% of total West Bank employed persons between the first quarter of 1997 and the third quarter of 2001 and 10.5% in the Gaza Strip over the same period. Investment in this sector is considerable, particularly by the private sector. \$6 billion was invested in the construction sector between 1994-2001, comprising housing units, public and commercial buildings, and infrastructure facilities. Investment in buildings rose from \$906 million in 1994 to \$1.18 billion in 2001. The sector is characterized by having several forward and backward linkages since a large number of products and services are used in buildings and complementary infrastructure. There were 5,180 enterprises involved in the construction industry in 2001, representing about 35% of all firms in the industrial sector, while 22% of workers in the industrial sector were employed in construction (MAS, 2002).

The construction industry is the vehicle through which physical development is achieved, and this is truly the locomotive of the national economy. The more resources, engineering know-how, labor, materials, equipment, capital, and market exchange provided from within the national economy, the higher the extent

of self reliance. The increasing complexity of infrastructure projects and the environment, within which they are constructed, place greater demands on construction managers to deliver projects on time, within the planned budget and with high quality (Enshassi, *et al.* 2003). The objective of this paper is to identify and rank causes of time waste according to their importance in construction projects in the Gaza Strip from contractors' viewpoint.

### Background about Time Waste

Waste in construction is not only focused on the quantity of material waste in construction, but also related to time waste. Palestine suffers from time waste like other developing countries, such as Lebanon (Mezher an Tawil, 1998), Thailand (Ogunlana, *et al.* 1996), Indonesia (Kaming, *et al.* 1997; Alwi, *et al.* 2000), Nigeria (Elinwa and Joshua, 2001; Aibinu and Jagboro, 2002; Aibinu and Odeyinka, 2006), Ghana (Frimpong, *et al.* 2003), Jordan (Al-Moumani, 2000; Odeh and Battaineh 2002), Malaysia (Abudul-Rahman, *et al.* 2006, 2008; Alaghbari, *et al.* 2007), Kuwait (Koushki, *et al.* 2005), UAE (Faridi and El-Sayegh, 2006), Saudi Arabia (Alwi, *et al.* 2000; Odeh and Battaineh, 2002; Chan and Kumaraswamy, 2002; Assaf and AL-Hejji, 2006; and Alaghbari, *et al.* 2007) classified factors that cause time overruns into eight groups (owner, contractor, consultant, material, labour and equipment, contract, contractual relationships and external factors. Ogunlana, *et al.* (1996) examined construction delays in a fast-growing economy, comparing Thailand with other economies. Aibinu and Jagboro (2002), in their study of the growing problem of construction delay in Nigeria, examined the effects of delays on the delivery of construction projects. Utilizing a questionnaire survey of 61 construction projects, the authors identified and assessed the impact of delays on the delivery of construction projects. The duration of construction tasks consists of process (and reprocess or rework) time, inspection time, move time, and wait time (Koskela, 1992). Only process time is considered to be value adding activity. The reminders are non-value adding activities. Koskela (2004) defined the value adding activity as the activity that converts

material and/or information towards that which is required by the customer; non value adding activity (also called waste) as the activity that takes time, resources or space but does not add value. However, all value adding time belongs to process time, not all process time is value adding. Processes are also subject to wastes resulting from overproduction, wrong construction method, defects, and poor optimization in performance tasks (Polat and Ballard, 2004).

Non value-adding activities can be further divided into contributory activities and unproductive activities. Contributory activities are work elements that do not directly add to output but are generally required and sometimes essential in carrying out an operation. These include handling material at the work face, receiving instructions, reading drawings, cleaning up the workplace, ancillary work and so on. Unproductive activities, on the other hand, are those that are not necessary such as being idle or doing something that is unrelated to the operation being carried out or that is in no way necessary to complete the operation; and these could be eliminated from the production flow without diminishing the value of the work. These include walking empty handed, work carried out using the wrong tools or the wrong procedures, and rectifying mistakes (Zhao and Chua, 2003).

In Turkey, Polat and Ballard (2004) have determined the time waste in construction. They have categorized time waste into four categories, design, procurement, operation and others. Design category consists of: interaction between various specialists, rework due to design changes and revisions, lack of information about types and sizes of materials on design documents, error in information about types and sizes of materials on design documents, contradiction in design documents, and delay in approval of drawing. Procurement category consists of: delay in material supply, receiving materials that do not fulfill project requirements defined on design documents, and waiting for replacement, and delay in transportation and/or installation of equipment. Operation category consists of: scarcity of crews, unrealistic master schedule, rework due to workers' mistakes, scarcity of equipment, waiting for design documents and

drawings, lack of coordination among crews, choice of wrong construction method, and accidents due to lack of safety. Others causes category consists of: irregular cash flow, severe weather conditions, bureaucracy and red tape, unpredictable local condition, and acts of God.

In Egypt, Garas, *et al.* (2001) stated that time waste in construction can be resulted from: over ordering/ excess, overproduction, wrong handling, wrong storage, manufacturing defects, and theft and vandalism. Al-Khalil and AL-Ghafly (1999) determined 60 causes of time waste in Saudi Arabia which lead to delay of projects. They found that the most important causes are: shortage of materials required, delay in materials delivery, changes in materials prices, changes in materials specifications, shortage of equipment required, failure of equipment, shortage of supporting and shoring installations for excavations, inadequate equipment used for the works, shortage of manpower, and low skill of manpower. Delay in payments is widely occurring in the construction projects in Gaza Strip, which affect on the progress of projects. The main causes of construction delay in Gaza Strip are unavailability of materials, political instability, bad weather, design changes, additional works, owners delay, and site conditions (Sawalhy and Enshassi, 2005). Design changes and delays in design approval would have caused delay to the project (Williams, *et al.* 1995). Causes of the waiting period are interference with other crews, workforce management, insufficient work to perform, weather, equipment, design error, rework, conversion technology, and materials (Ballard, *et al.* 2004).

## RESEARCH METHODOLOGY

In this research, a quantitative approach was selected to determine the effects degree of the causes of materials waste in construction projects in the Gaza Strip. This study considered 92 factors which cause time waste in construction project. These factors have been selected after a careful review of literature and previous related research (Bossink and Brouwers, 1996; Formoso, *et al.* 1999; Al-Khalil and AL-Ghafly, 1999; Ekanayake and Ofori, 2000; Alwi, *et al.* 2000;

Poon, *et al.* 2001; Garas, *et al.* 2003, and Poon, 2007; Wang and Robin, 2004; Polat and Ballard, 2004; Tam and Tam, 2006; Esin and Cosgun, 2007). These factors were distributed into five groups: design and documentation, materials, operation, site management and practices, and site supervision (Bossink and Brouwers, 1996; Ekanayake and Ofori 2000, 2004).

A pilot study was conducted with ten project managers in the field who were able to provide competent information. The pilot study was conducted to test the validity and reliability of the research, and to ensure that the information sought in the questionnaire would be relevant to the study. The chosen sample was invited to participate in the piloting process and they were provided with an explanation about the study and had been asked to complete the prepared questionnaire. The questionnaire has been validated by criterion-related reliability and structure validity test (Spearman test). As a result of the pilot study, some changes, annulments, additions and modifications were incorporated in the questionnaire before it was used for the main data collection study.

An ordinal scale measure was used for eliciting data on respondents' perceptions. Ordinal scale is a ranking or rating data that normally uses integers in ascending or descending order. The respondents were asked to rate their agreement or disagreement concerning the stated dispute causes on a five-point Likert scale, where 5 = strongly agree, 4 = agree, 3 = no idea, 2 = disagree, and 1 = strongly disagree. The numbers assigned to the agreement or degree of influence (1, 2, 3, 4, and 5) doesn't indicate that the intervals between scales are equal, nor do they indicate absolute

quantities. They are merely numerical labels (Naom, 1998). The normal distribution test was conducted and it has been found that the collected data were normally distributed. The population of this study was 80 respondents representing eighty construction firms. The designation of the respondents was: 83% company director, 37% project manager, 14% site engineer, and 11% office engineer. The contract values range from 1 million US\$ to 10 million US\$. The distributions of the surveyed contracting companies in the Gaza Strip were: 53% in Gaza city governorate, 22% in Khanunes, 10% in Rafah, 10% in North area, and 5% in the Middle area.

## RESULTS AND DISCUSSION

This section deals with the analysis of the information gathered from the questionnaire survey and includes the identification of the 92 critical causes of time waste. The discussion about the questionnaire survey is organized in five groups.

### Main Groups

The questionnaire of this study considered 92 factors which causes time waste in construction, and those factors were distributed into five groups namely, design and documentation; materials; operation; site management and practices; site supervisor. Table (1) illustrates the mean and rank of each group. The survey revealed that the site supervisor group is the major cause of time waste with mean 3.9363 and highest ranking, while for materials group has the lowest rank with mean value 3.1922.

**Table 1.** Mean and ranks of main time waste groups.

S. no.	Category of time waste	Mean	Ranking
5	Site supervisor	3.9363	1
3	Operation	3.8105	2
4	Site management and practices	3.7606	3
1	Design and documentation	3.5525	4
2	Materials	3.1922	5

## Design and Documentation Group

The mean and rank of each of the sub-factors of the design and documentation group which causes time waste are presented in (Table 2) in a descending order. The results in (Table 2) showed that “*rework that don’t comply with drawings and specifications*” factor was ranked in the first position with mean value 4.46. It was also ranked in the highest position among the ninety-two factors that caused time waste (Table 1, appendix). The respondents contractors considered rework that don’t comply with drawings and specifications as major contributors to time waste in the Gaza Strip construction industry. The main causes for this problem were; lake of supervision, poor management, and inadequate subcontractors who execute some works.

**Table 2.** Mean and rank of design and documentation group factors.

Factor	Mean	Rank
<b>Rework that don&gt;t comply to drawings and specifications</b>	4.46	1
<b>Ambiguities, mistakes, and inconsistencies in drawings</b>	4.05	2
<b>Selecting the lowest bidder subcontractor</b>	3.93	3
<b>Waiting for design documents and drawings</b>	3.86	4
<b>Incomplete contract documents at commencement of project</b>	3.81	5
<b>Design changes and revisions</b>	3.73	6
<b>Ambiguities, mistakes, and changes in specifications</b>	3.68	7
<b>Lack of information in the drawings</b>	3.59	8
<b>Errors in contract documents</b>	3.43	9
<b>Original contract duration is too short</b>	3.43	9
<b>Lack of information about types and sizes of materials on design documentations</b>	3.31	10
<b>Complexity of detailing in the drawings</b>	3.10	11
<b>Lack of attention paid to dimensional of products</b>	3.06	12
<b>Selection of low quality products</b>	3.04	13
<b>Determination of types and dimensions of material without considering waste</b>	2.83	14

The results in (Table 2) showed that “*ambiguities, mistakes, and inconsistencies in drawings*” factor was ranked in the second

position with mean value 4.05. It was also ranked in the eighth position among the ninety-two factors that caused time waste (Table 1, appendix). It is a basic cause of rework because if it is found in drawings, work may be stopped to consult the supervisor engineer who in turn may return to the consultant. That’s also considered waste in time. “*Selecting the lowest bidder subcontractor*” factor was ranked in the third position with mean value 3.93. It was also ranked in the fourteenth position among the ninety-two factors that caused time waste. Subcontractors with the lowest bidder endeavour to achieve profit by executing the work with minimum duration, but they neither haven efficiency nor enough tools and equipments for execution, this leads to time waste.

The results in (Table 2) showed that “*waiting for design documents and drawings*” factor was ranked in the fourth position with mean value 3.86. It was also ranked in the nineteenth position among the ninety-two factors that caused time waste (Table 1, appendix). Although waiting for design documents and drawings had the fourth position in design group in the Gaza Strip construction industry, other studies revealed that this factor wasn’t considered as a significant source of time waste. Polat and Ballard (2004) revealed that 9% only of the respondents considered that waiting for design documents and drawings caused time waste. Garas, *et al.* (2001) mentioned in their study that the dominant causes of waste generation in Egyptian construction projects were due to uncompleted design.

## Material Group

The results in (Table 3) showed that “*lack of material*” factor was ranked in the first position with mean value 4.25. It was also ranked in the second position among the ninety-two factors that caused time waste (Table 1, appendix). Lack of materials in Gaza Strip is due to closure and lack of natural resources. That leads to time waste due to waiting for material to be delivered to construction site. But in Saudi Arabia this factor wasn’t considered a major factor affecting time waste because the materials are available. “*Poorly schedule to procurement the materials*” factor was ranked in the second position with mean value 3.90. It was also ranked in the

sixteenth position among the ninety-two factors that caused time waste. This problem has led to delay in material supply and causes time waste resulting from the waiting period. This result is consistent with the previous study conducted by Zhao and Chua (2003). A similar result was found by Polat and Ballard (2004), their study revealed that 72% of the respondents considered that the delay of material supply causes time waste. A similar result was found by Alwi, *et al.* (2000).

Al-Khalil and AL-Ghafly (1999) mentioned that delay of material was ranked in the twenty-sixth position among sixty factors which cause waste and project delay.

The results in (Table 3) showed that “*purchased materials that don’t comply with specification*” factor was ranked in the third position with mean value 3.88. It was also ranked in the eighteenth position among the ninety-two factors that caused time waste (Table 1, appendix).

**Table 3.** Mean and rank of material group factors.

Factor	Mean	Rank
Lack of materials (closure)	4.25	1
Poorly schedule to procurement the materials	3.90	2
Purchased materials that don't comply with specification	3.88	3
Ordering of materials that do not fulfill project requirements defined on design documents, and waiting for replacement	3.81	4
Changes in materials prices	3.65	5
Overordering or underordering due to mistake in quantity surveys	3.48	6
Substitution of a material by amore expensive one (with an unnecessary better performance)	3.45	7
Manufacturing defects	3.43	8
Theft and vandalism	3.40	9
Overordering or underordering due to lack of coordination between warehouse and construction crews	3.30	10
Poor quality of materials	3.29	11
Poor storage of materials	3.26	12
Lack of on site materials control	3.25	13
Wrong handling of materials	3.18	14
Damage materials on site	3.14	15
Conversion waste from cutting uneconomical shapes	3.14	15
Over-sized any elements during execution	3.06	16
Unnecessary material handling	3.01	17
Lack storage of materials near of construction site	3.01	17
Insufficient instructions about handling	2.91	18
Damage during transportation	2.89	19
Wrong storage of materials	2.88	20
Inappropriate storage leading to damage or deterioration	2.88	20
Using excessive quantities of materials more than the required	2.80	21
Lack of possibility to order small quantities	2.74	22
Overproduction/Production of a quantity greater than required or earlier than necessary	2.74	22
Insufficient instructions about storage and stacking	2.69	23
Inadequate stacking and insufficient storage on site	2.65	24
Unnecessary inventories in site which lead to waste	2.54	25

The respondents' contractors considered purchased materials that don't comply with specification as major contributors to time waste in the Gaza Strip construction industry because of waiting for material until replacement and purchasing the required material. Al-Khalil and AL-Ghafly (1999) mentioned that this factor was ranked in the forty position among sixty factors which cause waste and project delay. "*Ordering of materials that do not fulfill project requirements defined on design documents, and waiting for replacement*" factor was ranked in the fourth position with mean value 3.81. It was also ranked in the twenty-second position among the ninety-two factors that caused time waste. The respondents considered this factor as the most important cause of time waste. This problem may result from either mistake in purchasing requisitions or the supplier's delivery of incorrect materials. A similar result was found by Polat and Ballard (2004), their study revealed that ordering of materials that do not fulfill project requirements was the second cause of time waste with frequency 53%. As well as, this result is consistent with the pervious study conducted by Bossink and Brouwers (1996).

The results in (Table 3) showed that "*changes in materials prices*" factor was ranked in the fifth position with mean value 3.65. It was also ranked in the thirty-first position among the ninety-two factors that caused time waste (Table 1, appendix). In Gaza Strip, prices of materials are affected by closure and become very high, so a contractor has to wait low prices. This problem is considered the major cause of time waste. Al-Khalil and AL-Ghafly (1999) mentioned that changes in materials prices was ranked in the thirty-seventh position among sixty factors which cause waste and project delay. "*Overordering or underordering due to mistake in quantity surveys*" factor was ranked in the sixth position with mean value 3.48. It was also ranked in the forty position among the ninety-two factors that caused time waste. The respondents considered this factor lead to scarcity of material in site and waiting the material. Ekanayake and Ofori (2000) found in their study that ordering errors (too much or too little) was ranked in the second position in procurement group.

### Operation Group

The results in (Table 4) showed that "*rework due to workers' mistakes*" factor was ranked in the first position with mean value 4.24. It was also ranked in the third position among the ninety-two factors that caused time waste (Table 1, appendix). Workers mistakes may be as a result of their inefficiency, inexperience, or the contractor's bad supervision. In their study about the dominant causes of waste generation in the Egyptian construction industry, Garas, et al. (2001) found that untrained labors make mistakes more frequently. Polat and Ballard (2004) revealed that 16% of the respondents considered that workers' mistakes brought time waste.

The results in (Table 4) showed that "*effects of political and social conditions*" factor was ranked in the second position with mean value 4.14. It was also ranked in the fifth position among the ninety-two factors that caused time waste (Table 1, appendix). Political instability is represented in closure which leads to waste in time. Social conditions also affect work process e.g. if something wrong happened to the owner, work would stop. Although effects of political and social conditions have the fifth position among the ninety-two factors in this study, other studies revealed that this factor didn't affect time waste. Al-Khalil and AL-Ghafly (1999) in their study in Saudi Arabic stated that effects of political and social conditions was ranked in the forty-sixth position among the sixty factors that caused project delay. Polat and Ballard (2004), their study revealed that unpredictable local conditions in Turkey didn't have a major effect on time waste with frequency 6% only.

The results in (Table 4) showed that "*equipment frequently breakdown*" factor was ranked in the third position with mean value 4.06. It was also ranked in the seventh position among the ninety-two factors that caused time waste (Table 1, appendix). This problem was due to several reasons: using old equipments as purchasing new equipments need high cost, working on them for long hours and following days and after finishing a project and a contractor may rent his equipments to others. If equipments breakdown, work will stop and in turn it causes waste in time. Al-Khalil and AL-Ghafly (1999)

**Table 4.** Mean and rank of operation group factors.

Factor	Mean	Rank
Rework due to workers' mistakes	4.24	1
Effects of political and social conditions	4.14	2
Equipment frequently breakdown	4.06	3
Using untrained labors	4.00	4
Shortage of manpower (skilled, semi-skilled, unskilled labor)	3.98	5
Shortage of tools and equipments required	3.98	5
Problems between the contractor and his subcontractors	3.93	6
Use of incorrect material, thus requiring replacement	3.91	7
Poor workmanship	3.90	8
Tradesmen slow/ineffective	3.90	8
Poor technology of equipment	3.89	9
Waiting of workers or materials or equipments to arrive	3.84	10
Subsurface site conditions materially differing from contract documents	3.83	11
Unfriendly attitudes of project team and labors	3.81	12
Lack of coordination among crews	3.80	13
Choice of wrong construction method	3.78	14
Damage to work done caused by subsequent trades	3.75	15
Severe weather conditions	3.74	16
Delays in passing of information to the contractor on products	3.69	17
Difficulty in performance and professional work	3.64	18
Lack of workers or tradesmen or subcontractors' skill	3.63	19
Accidents due to negligence	3.63	19
Difficulties in obtaining work permits	3.61	20
Effects of subsurface conditions (type of soil, utility lines, water table)	3.55	21
Interaction between various specialists	3.08	22

mentioned that this factor was ranked in the twenty-ninth position among sixty factors which causes waste and project delay. In their study of dominant causes of waste generation in the Egyptian construction industry, Garas, *et al.* (2001) found that abnormal wear of equipment lead to time waste. Alwi, *et al.* (2000) mentioned that equipment frequently breakdown had a major effect on time waste and ranked in the second position in the operation group. "Using untrained labors" factor was ranked in the fourth position with mean value 4.00. It was also ranked in the ninth position among the ninety-two factors that caused time waste. They can't carry out their work quickly, which leads to waste in time. Garas, *et al.* (2001) mentioned in their study that the main source of time waste in Egyptian construction projects was due to untrained labours. Al-Khalil

and AL-Ghafly (1999) mentioned that untrained labors were ranked in the forty-fourth position among sixty factors which cause waste and project delay. "Shortage of manpower (skilled, semi-skilled, unskilled labor)" factor was ranked in the fifth position with mean value 3.98. It was also ranked in the tenth position among the ninety-two factors that caused time waste. Most labors work inside Israel due to high wages. When projects have to be executed in the Gaza Strip, labors won't be available. Al-Khalil and AL-Ghafly (1999) mentioned that shortage of manpower (skilled, semi-skilled, unskilled labor) was ranked in the twenty-ninth position among sixty factors which cause waste and project delay. Alwi, *et al.* (2002) mentioned that shortage of manpower had a major effect on time waste in Indonesian construction projects. Polat and



Ballard (2004) their study revealed that shortage of manpower in Turkish construction projects was considered a major effect in time waste with frequency 29%.

The results in (Table 4) showed that “*shortage of tools and equipments required*” factor was ranked in the fifth position with mean value 3.98. It was also ranked in the tenth position among the ninety-two factors that caused time waste (Table 1, appendix). Most construction companies haven’t all the equipments due to the high costs, so contractors have to rent the needed tools and equipments which may reach late. Al-Khalil and AL-Ghafly (1999) mentioned that shortage of tools and equipments required was ranked in the forty-eighth position among sixty factors which causes waste and project delay. Alwi, *et al.* (2000) mentioned that shortage of tools and equipments required had a major effect on waste in Indonesian construction projects with mean value 3.14.

### Site Management and Practices Group

The results in (Table 5) showed that “*slow in making decisions*” factor was ranked in the first position with mean value 4.06. It was also ranked in the seventh position among the ninety-two factors that caused time waste (Table 1, appendix). Slow in making decisions may be resulted from the contractor’s engineer or the consultant or the owner. e.g., if the engineer

wants to make any changes in drawings and specifications, he will go back to the consultant, who can’t decide without going back to the owner. The respondents’ contractors considered slow in making decisions as a major factor which affect time waste within construction projects. Al-Khalil and AL-Ghafly (1999) mentioned that slow in making decisions was ranked in the twelfth position among sixty factors which cause waste and project delay. Alwi, *et al.* (2000) considered the slow in making decision as a major factor contributes to time waste generation in Indonesian construction projects.

The results in (Table 5) showed that “*poor management and distribution of labors, materials and equipments*” factor was ranked in the second position with mean value 3.98. It was also ranked in the tenth position among the ninety-two factors that caused time waste (Table 1, appendix). The respondents considered poor management and distribution of labors, materials and equipments as a major factor that affect time waste within construction projects, because it lead to idle (waiting periods). A similar result was found by Garas, *et al.* (2001) in their study in Egyptian construction projects. “*Lack of waste management plan*” factor was ranked in the third position with mean value 3.96. It was also ranked in the eleventh position among the ninety-two factors that caused time waste. The respondents’ contractors considered the lack of

**Table 5.** Mean and rank of site management and practices group factors.

Factor	Mean	Rank
Slow in making decisions	4.06	1
Poor management and distribution of labors, materials and equipments	3.98	2
Lack of waste management plan	3.96	3
Ineffective control of the project progress by the contractor	3.96	3
Delay in commencement of project	3.84	4
Poor qualification of the contractor’s technical staff assigned to the project	3.83	5
Shortage of technical professionals in the contractor’s organization	3.80	6
Ineffective planning and scheduling of the project by the contractor	3.74	7
Poor coordination and communication by the contractor with the parties involved in the project	3.70	8
Poor provision of information to project participants	3.56	9
Lack of a quality management system aimed at waste minimization	3.54	10
Poor site layout	3.51	11
Lack of strategy to waste minimization	3.41	12

waste management plan as a major factor which affected time waste in Gaza Strip construction projects. A similar result was found by Poon, *et al.* (2001) in Hong Kong.

The results in (Table 5) showed that “*ineffective control of the project progress by the contractor*” factor was ranked in the third position with mean value 3.96. It was also ranked in the eleventh position among the ninety-two factors that caused time waste (Table 1, appendix). It causes waste in time because a contractor may have more than one project and don't follow a schedule at project stages. The respondents considered that the waste may be resulted in all stages due to ineffective control. Faniran and Caban (1998) revealed that inadequate control plan leads to waste in Australian construction projects and ranked in the sixth position with 14.3 severity indexes. However, Al-Khalil and AL-Ghafly (1999) mentioned that ineffective control of the project progress by the contractor was ranked in the fifty-second position among sixty factors which cause waste and project delay.

### Site Supervisor Group

The results in (Table 6) showed that “*uncooperative owner with the contractor and delay of claims and payments*” factor was ranked in the first position with mean value 4.20. It was also ranked in the fourth position among the ninety-two factors that caused time waste (Table 1, appendix). Delay in project process is always due to inadequate money to excite work. The respondents considered this factor as a major cause contributes to time waste in Gaza Strip. A similar result was found by Al-Khalil and AL-Ghafly (1999) which indicated that uncooperative owner with the contractor and delay of claims and payments was ranked in the third position among sixty factors which cause waste and project delay.

The results in (Table 6) showed that “*owner's poor communication with the construction parties and government authorities*” factor was ranked in the second position with mean value 4.11. It was also ranked in the sixth position among the ninety-two factors that caused time waste (Table 1, appendix). The respondents considered this factor as a major cause contributes to time waste in Gaza Strip. A similar result was found by Al-Khalil and AL-Ghafly (1999) which indicated

that the owner's poor communication with the construction parties and government authorities was ranked in the seventh position among sixty factors which causes waste and project delay. “*Lack of supervision and delay of inspections*” factor was ranked in the third position with mean value 3.98. It was also ranked in the tenth position among the ninety-two factors that caused time waste. Alwi, *et al.* (2002) considered the lack of supervision as a major factor causing waste in construction projects, and was ranked in sixth position in human resource group.

“*Delay in performing inspection and testing by the consultant engineer*” factor was ranked in the seventh position with mean value 3.89. It was also ranked in the seventeenth position among the ninety-two factors that caused time waste. The respondents didn't consider this factor as a major factor contributes to time waste generation in the Gaza Strip. Al-Khalil and AL-Ghafly (1999) mentioned that delay in performing inspection and testing by the consultant engineer was ranked in the twenty-fourth position among sixty factors which causes waste and project delay.

The results in (Table 6) showed that “*poor coordination and communication between the consultant engineer and other parties involved*” factor was ranked in the eighth position with mean value 3.83. It was also ranked in the twenty-first position among the ninety-two factors that caused time waste (Table 1, appendix). The respondents didn't consider this factor as a major factor contributes to time waste generation in Gaza Strip. Al-Khalil and AL-Ghafly (1999) mentioned that poor coordination and communication between the consultant engineer and other parties involved was ranked in the thirteenth position among sixty factors which causes waste and project delay. “*Delay to deliver the site to the contractor by the owner*” factor was ranked in the ninth position with mean value 3.68. It was also ranked in the thirty position among the ninety-two factors that caused time waste. The respondents didn't consider this factor as a major factor contributes to time waste generation in Gaza Strip. Al-Khalil and AL-Ghafly (1999) mentioned that delay to deliver the site to the contractor by the owner was ranked in twenty-sixth position among sixty factors which cause waste and project delay.

**Table 6.** Mean and ranking of site supervisor group factors.

Factor	Mean	Rank
Uncooperative owner with the contractor and delay of claims and payments	4.20	1
Owner's poor communication with the construction parties and government authorities	4.11	2
Lack of supervision and delay of inspections	3.98	3
Poor qualification of consultant engineer's staff assigned to the project	3.95	4
Change orders	3.94	5
Suspension of work by the owner	3.91	6
Slow response from the consultant engineer to contractor inquiries	3.89	7
Delay in performing inspection and testing by the consultant engineer	3.89	7
Poor coordination and communication between the consultant engineer and other parties involved	3.83	8
Delay to deliver the site to the contractor by the owner	3.68	9

### Over-all Ranks of All Factors Causing Time Waste

Table 1 (appendix) outlines the factors causing time waste in descending manner. It indicate that the highest five factors are “rework that don't comply with drawings and specifications; lack of materials (closure); rework due to workers' mistakes; effects of political and social conditions; and owner's poor communication with the construction parties and government authorities” with mean ranks 4.46, 4.25, 4.24, 4.14 and 4.11 respectively. It has been noticed that the “unnecessary inventories in site which lead to waste; inadequate stacking and insufficient storage on site; insufficient instructions about storage and stacking; overproduction/production of a quantity greater than required or earlier than necessary; and lack of possibility to order small quantities” are the lowest five factors that causing time with mean ranks 2.54, 2.65, 2.69, 2.74 and 2.74.

### CONCLUSION

This study focused on time waste in construction projects in the Gaza Strip. The results indicated that reworks that don't comply with drawing and specifications, lack of materials, rework due to workers' mistakes, effects of social and political conditions and owner's poor communication with the construction parties are the most five important sources of time waste during the construction process. The survey revealed that the site supervisor group is the major

cause of time waste. Knowledge about waste reduction techniques is poor in the Palestinian construction industry. This study showed that the lack of skilled workers was a major cause of time waste. Managerial problems in stages that precede production are among the most important causes of waste.

These include lack of optimization during design in the use of resources lead to cutting, mistakes in the procurement of materials and waiting to replacement or ordering additional materials, lack of staking of materials and poor communication with the construction parties. The application of methods of waste identification is required urgently in the construction industry in Gaza Strip. These methods are needed to assist construction managers to identify time waste and eliminate it within construction process. It is clear that the responsibility of the elimination of waste depends on client, consultants, construction managers, suppliers, foremen and workers. By identifying the incidence of time waste during a project, construction managers are able to identify easily the preventions for reducing the waste, leading to increase project profit. Contractors should play a key role to reduce time waste in construction process. They are also advised to plan the delivery of materials on site and their distribution to the workplaces. It would be appropriate to arrange formal and informal education and training in time waste management for all concerned parties in the construction industry.

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## APPENDIX

**Table 1.** Mean and rank of over-all factors causing time waste.

<b>Factors</b>	<b>Group</b>	<b>Mean</b>	<b>Rank</b>
<b>Rework that don&gt;t comply to drawings and specifications</b>	G1	4.46	1
<b>Lack of materials (closure)</b>	G2	4.25	2
<b>Rework due to workers' mistakes</b>	G3	4.24	3
<b>Uncooperative owner with the contractor and delay of claims and payments</b>	G5	4.20	4
<b>Effects of political and social conditions</b>	G3	4.14	5
<b>Owner's poor communication with the construction parties and government authorities</b>	G5	4.11	6
<b>Equipment frequently breakdown</b>	G3	4.06	7
<b>Slow in making decisions</b>	G4	4.06	7
<b>Ambiguities, mistakes, and inconsistencies in drawings</b>	G1	4.05	8
<b>Using untrained labors</b>	G3	4.00	9
<b>Shortage of manpower (skilled, semi-skilled, unskilled labor)</b>	G3	3.98	10
<b>Shortage of tools and equipments required</b>	G3	3.98	10
<b>Poor management and distribution of labors, materials and equipments</b>	G4	3.98	10
<b>Lack of supervision and delay of inspections</b>	G5	3.98	10
<b>Lack of waste management plan</b>	G4	3.96	11
<b>Ineffective control of the project progress by the contractor</b>	G4	3.96	11
<b>Poor qualification of consultant engineer's staff assigned to the project</b>	G5	3.95	12
<b>Change orders</b>	G5	3.94	13
<b>Selecting the lowest bidder subcontractor</b>	G1	3.93	14
<b>Problems between the contractor and his subcontractors</b>	G3	3.93	14
<b>Use of incorrect material, thus requiring replacement</b>	G3	3.91	15
<b>Suspension of work by the owner</b>	G5	3.91	15
<b>Poorly schedule to procurement the materials</b>	G2	3.90	16
<b>Poor workmanship</b>	G3	3.90	16
<b>Tradesmen slow/ineffective</b>	G3	3.90	16
<b>Poor technology of equipment</b>	G3	3.89	17
<b>Slow response from the consultant engineer to contractor inquiries</b>	G5	3.89	17
<b>Delay in performing inspection and testing by the consultant engineer</b>	G5	3.89	17
<b>Purchased materials that don&gt;t comply with specification</b>	G2	3.88	18
<b>Waiting for design documents and drawings</b>	G1	3.86	19
<b>Waiting of workers or materials or equipments to arrive</b>	G3	3.84	20
<b>Delay in commencement of project</b>	G4	3.84	20
<b>Subsurface site conditions materially differing from contract documents</b>	G3	3.83	21
<b>Poor qualification of the contractor's technical staff assigned to the project</b>	G4	3.83	21
<b>Poor coordination and communication between the consultant engineer and other parties involved</b>	G5	3.83	21
<b>Incomplete contract documents at commencement of project</b>	G1	3.81	22
<b>Ordering of materials that do not fulfill project requirements defined on design documents, and waiting for replacement</b>	G2	3.81	22
<b>Unfriendly attitudes of project team and labors</b>	G3	3.81	22
<b>Lack of coordination among crews</b>	G3	3.80	23
<b>Shortage of technical professionals in the contractor's organization</b>	G4	3.80	23

**Cont. Table 1.** Mean and rank of over-all factors causing time waste.

<b>Choice of wrong construction method</b>	G3	3.78	24
<b>Damage to work done caused by subsequent trades</b>	G3	3.75	25
<b>Severe weather conditions</b>	G3	3.74	26
<b>Ineffective planning and scheduling of the project by the contractor</b>	G4	3.74	26
<b>Design changes and revisions</b>	G1	3.73	27
<b>Poor coordination and communication by the contractor with the parties involved in the project</b>	G4	3.70	28
<b>Delays in passing of information to the contractor on products</b>	G3	3.69	29
<b>Ambiguities, mistakes, and changes in specifications</b>	G1	3.68	30
<b>Delay to deliver the site to the contractor by the owner</b>	G5	3.68	30
<b>Changes in materials prices</b>	G2	3.65	31
<b>Difficulty in performance and professional work</b>	G3	3.64	32
<b>Lack of workers or tradesmen or subcontractors' skill</b>	G3	3.63	33
<b>Accidents due to negligence</b>	G3	3.63	33
<b>Difficulties in obtaining work permits</b>	G3	3.61	34
<b>Lack of information in the drawings</b>	G1	3.59	35
<b>Poor provision of information to project participants</b>	G4	3.56	36
<b>Effects of subsurface conditions (type of soil, utility lines, water table)</b>	G3	3.55	37
<b>Lack of a quality management system aimed at waste minimization</b>	G4	3.54	38
<b>Poor site layout</b>	G4	3.51	39
<b>Overordering or underordering due to mistake in quantity surveys</b>	G2	3.48	40
<b>Substitution of a material by amore expensive one (with an unnecessary better performance)</b>	G2	3.45	41
<b>Errors in contract documents</b>	G1	3.43	42
<b>Original contract duration is too short</b>	G1	3.43	42
<b>Manufacturing defects</b>	G2	3.43	42
<b>Lack of strategy to waste minimization</b>	G4	3.41	43
<b>Theft and vandalism</b>	G2	3.40	44
<b>Lack of information about types and sizes of materials on design documentations</b>	G1	3.31	45
<b>Overordering or underordering due to lack of coordination between warehouse and construction crews</b>	G2	3.30	46
<b>Poor quality of materials</b>	G2	3.29	47
<b>Poor storage of materials</b>	G2	3.26	48
<b>Lack of on site materials control</b>	G2	3.25	49
<b>Wrong handling of materials</b>	G2	3.18	50
<b>Damage materials on site</b>	G2	3.14	51
<b>Conversion waste from cutting uneconomical shapes</b>	G2	3.14	51
<b>Complexity of detailing in the drawings</b>	G1	3.10	52
<b>Interaction between various specialists</b>	G3	3.08	53
<b>Lack of attention paid to dimensional of products</b>	G1	3.06	54
<b>Over-sized any elements during execution</b>	G2	3.06	54
<b>Selection of low quality products</b>	G1	3.04	55
<b>Unnecessary material handling</b>	G2	3.01	56
<b>Lack storage of materials near of construction site</b>	G2	3.01	56
<b>Insufficient instructions about handling</b>	G2	2.91	57

**Cont. Table 1.** Mean and rank of over-all factors causing time waste.

<b>Damage during transportation</b>	G2	2.89	58
<b>Wrong storage of materials</b>	G2	2.88	59
<b>Inappropriate storage leading to damage or deterioration</b>	G2	2.88	59
<b>Determination of types and dimensions of material without considering waste</b>	G1	2.83	60
<b>Using excessive quantities of materials more than the required</b>	G2	2.80	61
<b>Lack of possibility to order small quantities</b>	G2	2.74	62
<b>Overproduction/Production of a quantity greater than required or earlier than necessary</b>	G2	2.74	62
<b>Insufficient instructions about storage and stacking</b>	G2	2.69	63
<b>Inadequate stacking and insufficient storage on site</b>	G2	2.65	64
<b>Unnecessary inventories in site which lead to waste</b>	G2	2.54	65*

\* This is the rank of the last factor. It does not represent the number of factors because there are one or more factors which take the same rank.