THE HIGHEST-AFFECT PHASE ON MATERIALS MANAGEMENT EFFECTIVENESS IN SYRIAN CONSTRUCTION PROJECTS

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ABSTRACT

The materials importance in construction projects makes it necessary to track them from design stage to handling stage. Materials management is the plans, processes, and actions to track the materials along the project cycle. The problems related to supplying materials, tracking them during the implementation, and handling them are major challenges in construction projects. Through conducting surveys with construction projects managers in construction companies and engineering offices, this study highlights the aspects of the materials management in construction projects in Syria, through presenting how construction companies and engineering offices handle the materials and manage the construction site. Based on findings from the study, the procurement phase is the most challenging phase for effective materials management, which makes it the most affective phase among all the materials management phases. It also indicates the increase costs and delays in construction projects due to the reliance on traditional methods of tracking materials. This reflects the necessity of automating construction works, not only at the company level but also at the construction project sites level, through creating a system that can gather all the information related to the materials and give updates to track materials and take decisions in real-time.

KEYWORDS: Material management, Tracking, Effective phase, Procurement.

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المرحلة الأكثر تأثيراً على فعالية إدارة المواد في مشاريع التشييد السورية

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الملخص

إن أهمية المواد في موقع التشييد تجعل من الضروري تتبعها من مرحلة التصميم حتى مرحلة الاستعمال في التنفيذ. تعرف إدارة المواد بالخطط والعمليات والإجراءات لتتبع المواد خلال دورة حياة المشروع. إنّ المشاكل المتعلقة بتوريد المواد وتتبعها خلال عمليات تنفيذها واستعمالها تعتبر تحديات رئيسية في مشاريع التشييد. من خلال إجراء استبيانات مع مدراء المشاريع في شركات تشييد ومكاتب هندسية، سلطت هذه الدراسة الضوء على جوانب إدارة المواد في مشاريع التشييد في سوريا، عبر إظهار كيفية تعامل شركات التشييد والمكاتب الهندسية مع المواد وإدارتها في مواقع التشييد. بناءً على النتائج المستخلصة من هذه الدراسة، فإن مرحلة الشراء هي أكثر مراحل حياة المواد في المشروع من حيث التحديات التي تواجه الإدارة الفعالة لهذه المواد، وهو ما يجعلها المرحلة الأكثر فاعلية من بين كل مراحل إدارة المواد. كما تشير المقالة أيضاً إلى زيادة الكلفة والتأخيرات في مشاريع التشييد بسبب الاعتماد على الطرق التقليدية في إدارة المواد، وهذا يعكس ضرورة أتمتة أعمال التشييد ليس فقط على مستوى الشركة إنما أيضاً على مستوى موقع المشروع، عبر إحداث نظام الكتروني يمكن أن يجمع كل المعلومات المرتبطة بالمواد، ويعطي تحديثاتٍ تساهم في تتبع المواد واتخاذ القرارات بالوقت المناسب.

الكلمات المفتاحية: إدارة المواد، التتبع، المرحلة الفعالة، الشراء.

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INTRODUCTION

The management concept includes all the activities and studies to plan and adjust all the processes related to the project in each of its activities throughout the project cycle. The concept of management depends on the field of work and sector.

Management in construction projects has challenges for each phase of the project, from design to the closure of the project. Each stakeholder has an effect on project decisions, and the decisions taken during the design phase, affect by consequence the output during the implementation.

Site management practice is defined as a basic integrating process used to achieve organized and goal-oriented results in the area where building or construction work is being carried out (Dos Santos et al, 2002). Griffith and Watson (2004, 2) define site management as a set of four inter-related components: preliminary works, site organization, site layout, and welfare provision.

For the construction industry, there are two elements of management: the management of the construction companies or offices, and the management of the site. These elements of management happen in parallel and cross together at some points to reach the final product at the end. The management of the company differs from the site management, as it is similar to management in factories, and it is continued after the end of the project to start a new one, so it can be for many projects. While the site management starts with the project from the phase of planning till the closure of the project.

Due to the complexity of organizing site management work, there are many challenges that can affect the implementation plan and result in a negative output on cost, time, and quality. Many problems from the engineering and management side challenge construction sites, and affect time, plans, and budget. There are three categories of management and administration problems; technical, engineering, and site communication problems. The failure of management the construction sites is mainly related to the issues of communication between the professional team and the contractor (Bamisile, 2004). There have been many studies and attempts to systemize work in construction sites, but until now even in developed countries and in large projects, there are some points that cannot be organized.

Site management includes many aspects, such as management of equipment, management of human resources (workers and employees), and the most important aspect - which is the primary concern of those responsible for projects - the management of materials. Materials represent a large proportion of construction projects costs. They may represent 50-60% of the total project cost (Kasim et al, 2012, 447). As Ogunlana et al (1996) indicated, the important problem, which adversely affects the management of construction projects, is the improper handling of materials during site implementation activities. The inappropriate handling and management of materials severely hampers construction project performance. Jimoh (2012) found that the inadequate applying of the building standards regulations is the high affecting issue among 32 issues suggested by previous studies, while the least affecting one is the handling issues related to the insufficient concrete cover and early stripping of the formwork.

Materials management is the plans, processes, and actions to track materials from design stage to handling one during implementation. It includes the process of procurement, selecting vendors, delivering materials to the warehouse, organizing them inside the warehouse, and delivering them to the locations of installation. In other words, to track the life cycle of each material, from designing to handling.

Bell and Stukhart (1985) indicated that materials management is the system of planning and controlling all efforts to make

sure that the right quality and quantity of materials and equipment are received in a suitable time, at a reasonable cost, and available as needed.

The research of Zaha (2017) aims to define the materials management practices and the reasons for the ineffective material management in Maldives construction projects, to make the projects managers aware of those reasons during the implementation. The causes were also studied by (Patel & Vyas, 2011), in their research to study the ineffective materials and equipment management in the construction sites, since managing those resources will increase the project productivity related to the cost and time. Kasim (2008) discussed using the traditional methods in materials management in terms of the tracking processes and the unsuitable handling of materials during the implementation. Zaha (2017) indicated the relation between materials management process and project value, and found that the 3 causes of ineffective management are prices, time to investigate the non-qualified suppliers and materials availability.

The conditions of construction sites generally and, especially in Syria, impose considerable difficulties to apply on-site management of materials to the receipt, conformity of specifications, distribution, defining locations of use, and tracking. The reliance on traditional and non-specialized methods of material management leads to additional costs and delays in project scheduling.

RESEARCH OBJECTIVE

The conflict in Syria has affected all aspects of life, and construction work has been affected by this crisis in many aspects regarding all the needs of production, human resources, equipment, and materials. As mentioned above regarding the importance of materials in construction projects, the problems related to supplying the materials, tracking them during implementation, and handling them are major challenges in construction projects.

This study will highlight the aspects of materials management in construction projects in Syria, through demonstrating how construction companies and engineering offices handle materials and manage the construction site, in addition, to defining the most challengeable phase for effective materials management during the materials life cycle.

METHODOLOGY

1.1 Sampling:

To achieve the goals of the research, the study will highlight the aspects of materials management in construction projects in Syria, therefore defining the sample of the research is the first step to study the reality of the construction projects.

There are three items that affect the research results, the company (which implements the project), the engineer (or the responsible person for the project), and the project itself; so, each one of these items is a type of research sample. Construction projects in Syria are the main sample population of the study, and can represent the other construction projects in Syria. The engineer, as a responsible person for construction projects, can implement more than one project; so, he/she can participate in the survey by representing more than one project and he/she will have his/her own opinion regarding the reality of materials management in general. The type and the organization of the company play a role in defining the material management method, and the engineer, who will participate as a representative of his/her own project and give his/her own opinion about construction projects in Syria, can give information about his/her company where he/she works. The number of construction projects, engineers, and engineering companies and offices in Syria cannot be exactly defined; so, the sample size which will represent the sample population cannot be defined and the sampling method therefore is non-probability, using a purposive sample, by snowball method.

There are no criteria for selecting the targeted companies or offices in the research, except that they should be currently working on construction projects, regardless of the type of projects, for example, constructing a building, transportation infrastructure, etc. To define the companies and the engineering offices, a list was prepared based on personal information and social media. For the work of the private and public companies and offices the researcher relied on snowball sampling to add more sample units to the list.

1.2 Survey Design:

The researcher brainstormed questions that can be asked during the assessment, depending on previous studies and thesis about the reality of materials management in other countries in the world. For example, Zaha (2017, 28-41), who aimed to examine the current material management practice and its impact on construction projects in Maldives, through examining this process, and identifying the reasons of ineffective materials management in those construction projects. The methodology of Zaha's research was simultaneous triangulation, through surveys and interviews with the contractors, and subcontractors of some projects in Maldives. The following steps were taken to design the survey:

- Brainstorm the questions that will be used in the survey;
- Discuss these questions with some experts to obtain their feedback and comments;
- Categorize these questions and design the survey;
- Prepare Excel file for data entry, and analysis;
- Make a survey with a pilot sample to validate the survey related to the information and the design.

The type of research is a mix of quantitative and qualitative research, so the survey included open-ended questions and closed-ended questions, which have multi-choices or filling blank spaces. The survey is designed to have many categories depending on the research objectives, as the following:

1. Personal information of the respondents to define the respondents' experience and their role in the projects that are targeted by the survey.
2. Construction company or engineering office information, to get indication if there is any relation between the company or office type and the results and the practices in its construction projects.
3. Information about the assessed project, to get indication if there is any relation between the project type and location and its practices.
4. Quantitative information related to the assessed project, and define the management aspects related to the materials:

- The assessed project site includes information about preparing the locations to receive the materials, in addition to warehouse information;
- The conducted processes during implementation, which are related to requesting materials and the time of this request, and the processes of checking the received materials;
- The waste of materials and how the responsible persons of the project deal with this waste;
- The method of communication before and during the implementation and how it affects materials management;
- The technologies used for planning and tracking the materials.

5. Quantitative information depending on the opinion of respondents about:

- Importance scale to define the level of effect of some factors on the tracking of materials;
- The most factors affect the material management depending on the stage of the project;
- The reasons for waste of materials, and the warehouse standards related to storing materials.

6. Quantitative information related to the researcher's point of view:

This was obtained during visits to projects or companies or depending on the respondent responses, and is related to warehouse and the construction sites.

7. Qualitative information with open-ended questions about:

- The criteria of selecting the supplier;
- The potential problems with the suppliers;
- The restrictions on supplier work by construction companies and engineering offices.

After designing the assessment form, an Excel form was designed to enter data, then the assessment was tried with some respondents to obtain their comments about the design and the content. Based on their feedback, some modifications were made to the survey.

1.3 Conducting the research

According to the research methodology above and depending on the internet and personal information, the researcher selected construction companies and engineering offices to visit and interview employees who were in charge of construction projects, the heads of executing departments, or the company managers. In each company visited, the researcher asked about other companies or engineering offices that could participate in the survey; thus, new companies and offices, which were not in the prepared list, were visited too. For the same survey, the respondents responded to the information related to their own information, their companies or offices, his/her respected projects, and then depending on their opinion, they can respond to the other questions. Thus, one respondent can respond for more than one project and one company can have more than one respondent, and as mentioned above, this will be considered in analysing the data.

There are many types of interviews, which can be used to collect data and information: the unstructured interview, the semi-structured interview, and the structured interview. In this research, structured interviews are used to collect data, and the survey has many closed-ended questions in addition to open-ended ones. They are organized in a way to make the interview follow the project cycle.

SAMPLE INFORMATION

The researcher visited 11 companies and engineering offices with 34 respondents, who shared information about 46 projects. Since each respondent could have provided information about more than one project, the number of respondents was more than the number of projects. The highest percentage of respondents were civil engineers (approx.73%) acting as project managers for around 65% of the projects, which are the sample of the study. Around 53% of the respondents have MSC degrees while around 6% have PhD degrees. Regarding years of the experience: around 74% of the respondents have more than 10 years' experience in the engineering field. Figure 1 and Figure 2 below shows these percentag.

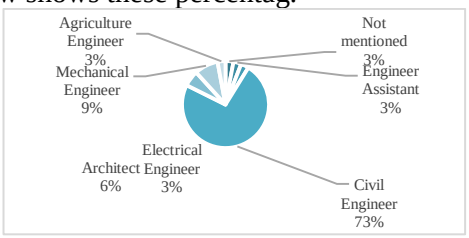

Figure (1): The percentage of respondents depending on their specializations.

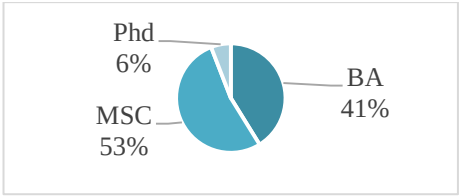

Figure (2): The percentage of respondents depending on their education level

Two engineering offices and nine engineering companies were included in the research. The number of engineering offices significantly decreased during the crisis, since a lot of engineers left the country. Also, the companies work was affected by the crisis

in spite of regaining some effectiveness in the last period. The researcher tried to diversify the assessed companies and engineering offices from the two sectors of work in Syria, to measure the affect of the work sector on the way of work regarding the materials tracking. The percentage of assessed public sector companies is 45%, which implemented 76% of targeted projects, while the assessed private sector ones are 55%, which implemented 24% of those projects. Those percentages show the weakness in the participation of the private sector in construction work in Syria. Although the private companies' work was more organized, their work was limited to a limited number of projects and most of them were small, while most of the projects of the public sector were sizeable.

Out of 46 projects assessed by the researcher, 44 projects were executed by targeted companies, while others were executed by engineering offices. The projects were in many governorates in Syria, such as Damascus, Rural Damascus, Tartous, Lattaquia, Hama, and Swida. 54% of those projects were residential construction, implemented by 64% of the targeted companies. While 41% of the transportation projects were implemented by the Public Company for Roads and Bridges in Syria. Infrastructure projects were only 4% of the targeted projects and all of them were implemented by the public companies.

Around 91% of the targeted companies are an executive company and they could provide the research with enough information about the executive reality in Syria. Around 49% of companies and the engineering offices implemented the targeted projects in their areas or they had branches in other areas of their projects which facilitated the management of the project.

The statistics are based on the projects, taking into consideration the opinion of respondents and companies; so, all percentages are attributed to the number of respondents or companies.

MATERIALS MANAGEMENT IN SYRIAN CONSTRUCTION PROJECTS

There were **tracks** for the materials and equipment movement in **around 41% of the assessed projects**. The warehouses existed in around 98% of the assessed projects. In only 39% of those projects the warehouse was prepared and organized according to the respondents. The effectiveness of warehouses management is related to three measurements, cost, time and quality in addition to the criteria of safety and productivity (Ghanem et al. 2008)

In Syrian construction projects, the concept of warehouse safety is restricted to prevent theft and save the materials from damage; so there is no plan or clear methodology to protect warehouses.

The following standards are applied in warehouses and construction sites:

Marginal storage: for around 28% of the assessed projects, the marginal storage was applied in case of the limited size of the warehouse. This reflects that the storage limitation in the warehouses is controlled by circumstances of materials availability and project's needs, without considering specific rules for storing.

Scheduling of materials: was applied in around 74% of the assessed projects, and this scheduling follows the project plan. For the 26% of the projects, the materials scheduling in the warehouse is not available, but there is only relying on the project plan, and most of those projects are implemented by public companies, although most of those projects are infrastructure.

- **Warehouse safety**: around 87% of the respondents tried to apply this in the best way they could in their project warehouses. Since there are no specifications used in applying this standard, safety is mainly to protect the materials from the risk of looting.

Reduce double-dealing: It is applied in only around 24% of the assessed projects since usually there is no culture of preparing

a plan to organize the processes of entering the materials to the warehouse and extracting them, but relying only on the project plan

Check receipt material: to make sure that all the quantities of the materials meet the required specifications in their quantity and quality. It is important for the head of the project to know that the received materials are the same as the planned ones, and in around 67% of the assessed projects, the check of the receipt is applied before receiving any quantity of the materials. For the rest, they only check the quantity, and they rely on their confidence in the supplier, which indicates the high importance of supplier reliability in facilitating the processes of materials management.

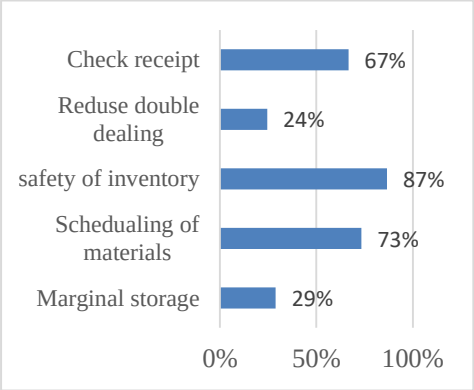

Figure (3): The applied standards in the warehouse and construction sites

Regarding the sector of the companies responsible for the projects, the previous percentage can be different between the private and the public sector of the project. The percentage of the private projects where there are tracks for the materials is less than the percentage of the public ones, as most of the projects of the public sector are larger than the private ones, this plays a role in making this difference. The check of receipt seems to be done more in the private sector than the public one. However, as it is shown in the following Figure 4, percentages for other points between the two sectors are similar:

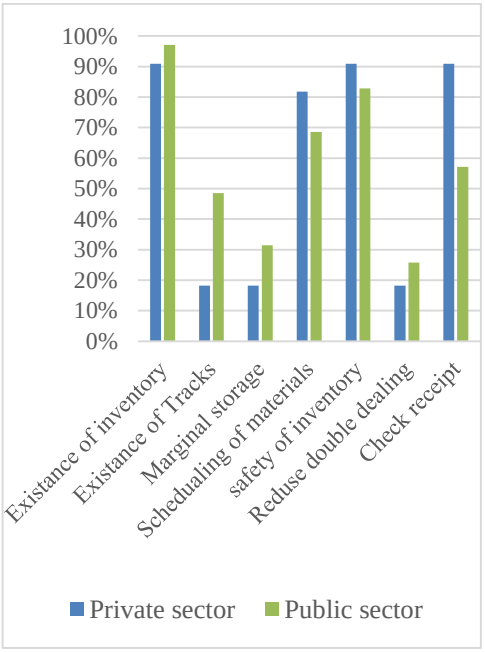

Figure (4): Percentages of the private sector projects and the public ones depending on the comparison points

In regard to the difference between the received materials and the requested ones in their quantity and quality, it is noted that these differences happen in around 30% of the assessed projects. This reflects the existence of checking the quantities in most of the projects, although the methods are old and paper-based consuming more effort and much time. They are also not accurate enough as the respondents' point of view. The following figures show the actions taken by the companies, in case there are differences in the quantities or qualities:

Table (1):No. projects depending on dealing way with the difference in the quantities of received materials

	return all materials	request for the shortage materials	depending on the shortage amount	impose fines	no response	Total
No. Project	3	27	8	5	3	46
%	7%	59%	17%	11%	7%	100%

Table (2): No. projects depending on the way of dealing with the difference in the qualities of received materials.

	return all materials but the process is fast	return all materials but the process is slow	no action	no response	Total
No. Project	21	20	2	3	46
%	46%	43%	4%	7%	100 %

Around 78% of the respondents confirm that the specifications of materials in markets are available. However, that is still depending on the availability of materials and the engineers' design of the executive schemas.

According to Garcia-Lopez and Fischer (2014), the supervisors in the construction projects need to know the materials information related to the people who are in charge to deal with the materials, the place and time of their use. Also, the site workers need clear instructions based on accurate follow-up on the materials on-site. Therefore, there is a huge need for coordination among the stakeholders on-site in aim to ensure sharing the information, monitor the implementation, and ensure that the correct decisions are taken in real-time. There are many ways that can be used for communication in the phases of project study and during the implementation, among all the stakeholders of the projects. The type of the main way of communication relies on the size of the company and the project.

Using the system in work requires a lot of organizing in the company, as most industrial and commercial companies rely for their communication on systems linked to the database, in addition to using emails, and verbal and written communications. Since the systems and databases contain the information of the projects electronically which can be extracted at any time, in addition to the ability to add any new information or modify by any person related to the project, there is a decreased need for written or verbal communication related to demand of information.

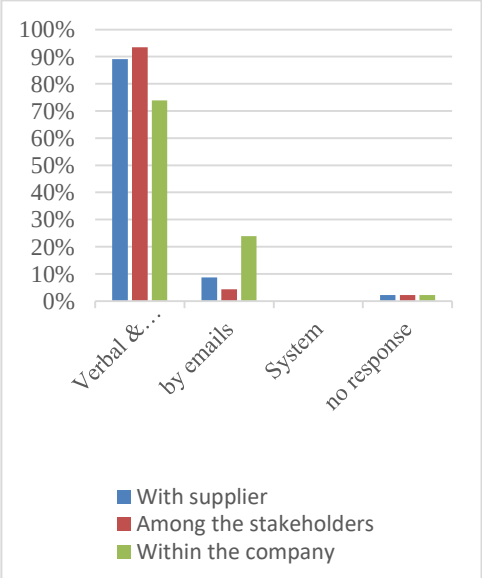

Figure (5): The percentage of companies relying on different communication technologies

Emails can facilitate communication and document it formally, but some information

cannot be shared or understood by email itself. In addition, with some types of communications, especially those related to routine work, emails will be too much in a way that cannot be understood or documented. The tracking and management of the materials can include routine work

sometimes, so using only email will make the work more complicated.

As shown in Figure 9, approximately 24% of assessed projects uses email in communication within the company. The percentages were less than that with suppliers or other stakeholders. There was no use of systems in the work of the companies.

Regarding the technologies used in executing some tasks related to the design or the planning of projects, most types of computer programs are still confined to programs which are not linked to network systems. According to the assessment, Excel and paperwork were mainly used in around 98% of the assessed projects, while the programs for preparing the organizing plan (Primavera, or MS project) were only used in around 20% of the assessed projects as a main electronic program, in addition to using Excel and paperwork. There is no reported use of electronic systems in any of the assessed projects according to the respondents. Kasim (2008) confirmed that Microsoft Excel is the most information and communication tools commonly used in the current industry work.

The use of a system linked to databases can manage project information, since it is created by other programs, which help in planning and following up on the projects, which mitigate the verbal and email communications, so it complicates the communications among the stakeholders.

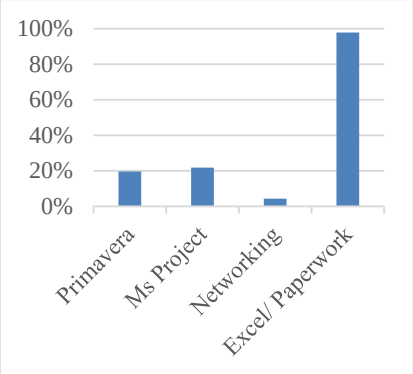

Figure (6): Projects depending on the used communication method

During the implementation of the project, sometimes the quantity of the materials can be insufficient, creating a need to demand more. Depending on the respondents, the additional requests happened in approximately 72% of assessed projects, which reflected the weakness of the plan in the phase of the organizational design. The maximum duration of providing the additional requests was from one day to one week, which was reported in around 43% of assessed projects. In around 33% of assessed projects, the duration was reported from one week to a half month, as it is shown by the next figure.

Monitoring mechanism of materials: There are many risks that can affect the materials during transportation, unloading, uploading, or in the construction site, in addition to the risk of installation, which is not the subject of the research. Those risks lead to the waste of materials, and in general, according to the assessment of some construction projects, there are no organized methods in monitoring the materials except using cameras in warehouses to protect the materials from theft. Engineers can define the waste in the projects, only on the general level of the project, and this depends on the difference between the supplied materials to the project and the consumed ones. In around 87% of the assessed projects, there were mechanisms of monitoring the waste, but that mechanism works only by the calculation of the difference, and there is no expectation or prediction that there will be a waste or a percentage of it during the implementation.

According to the respondents, in around 67% of assessed projects, the percentage of the waste was between 20% and 30%, while only in 22% of the same projects, the percentage was less than 10%. The high percentage of materials waste reflects weaknesses in materials management. Also, the calculation of the waste can be done during the process of loading the materials, as it happened in around 39% of the assessed projects. In around 50% of the projects, this

calculation happened during the unloading of the materials, and during the transportation of materials in around 30% of those projects. Only in around 26% of the projects the waste can be discovered from any robbery case. This reflects that most of the waste calculations processes are conducted during the unloading phase while the potential discovery of the cases of waste from the robbery is low. However, this calculation still relies on the traditional methods using the paperwork, which is risked by human interventions.

MAIN FACTORS DEFINING MATERIAL TRACKING TYPE:

The tracking of materials is the process that allows knowing the status of the supplied materials from reaching the site until handling them during implementation. To manage the materials tracking, there are many factors that play a role in defining the type and the methods of this management. One is the type of the materials and their quantities, which according to the 34 respondents, is a factor of high importance to define the method of materials tracking. This is because, with the existence of various materials, it is difficult for the engineers to follow up each type of the material, with a higher difficulty with increasing the quantity of those materials, which can lead to additional work to register all the received quantities and organize them.

The other factor is the location of the construction site and the warehouse, which means the distance between the places of storing the materials and the location of using the materials. There is a difference between the industry and the construction work regarding the distance between the warehouse location and the location of using the materials. In the industry, the warehouse is usually in the place of using the materials, or close to it, so the process of tracking the materials is easy, as the warehouse can serve many construction sites, or there can be one warehouse even within the same construction site. However, the construction site is wide, which means many materials have many directions during the implementation. The respondents indicated that the factor of the distance between the warehouse and the construction site has medium importance, as the effect of this factor depends on the ability of the engineers in organizing the process, despite the distance.

The workers are the main stakeholders who will deal with the materials and handle them in their final place, from the unloading to the handling. They are the main participants in unloading the materials in the warehouse, then organizing them inside it, and uploading them to the locations of use, until handling them in the locations of consumption, in addition to the process of monitoring the materials in all the mentioned steps along the implementation process. Also, the number of workers is a high importance factor on the materials tracking for the respondents, as in all the stages of the movement of the materials in the construction site. The existence of a system to adjust the dealing of the workers with the materials will help in following up the materials and tracking the movement of each material at each minute. The existence of a greater number of workers may cause more waste in materials, which leads to bad materials tracking, in case there is no system to organize their work.

The material tracking importance is different depending on the vastness of the construction project and its type. The bigger the site area is, the more complex the design or special type the construction project will be, the more the tracking materials importance will be, as the importance of the project reflects on all processes conducted during the implementation. For example, in infrastructure construction projects, the importance of materials tracking is more important than the one in other types of construction projects. According to the respondents, the type of construction project and its volume has high importance and

effect to define the type and method of materials tracking.

The construction executive site map is the plan done before starting the implementation of the project, to define the material tracks on-site, the site warehouse location, and the locations of the materials in their handling places during the implementation. More accurate site maps lead to high quality in tracking materials, which shows the importance of the construction executive site map before starting implementation. According to the respondents' opinions, it has high importance on the materials tracking. The importance of planning the site map is depending on the type of project, and it increases when the project is huge and has a lot of elements, such as the infrastructure construction project.

Around 62% of the respondents indicated that the accurate site map has a high effect on the materials tracking, while for the other factors, there was less percentage than 62% of the respondents indicated the same idea. Around 21% confirmed that the vastness of the project has a very high importance on materials tracking.

Due to what is mentioned above regarding the effect of the accurate site planning on tracking the materials, the respondents were asked about the necessity and realization of the site planning. Around 76% confirmed that the site planning is necessary to be done before the implementation, by defining the tracks of materials and the locations of storing, which will make the materials management easier. Thus, around 24% of the respondents indicated that the site planning is not realizable, due to the lack of using technologies that help to adjust applying the site planning during the implementation.

Out of 34 respondents, around 14% thought that there is no need to plan the site before the implementation, and it is not realizable, especially in construction work in Syria, and with the unavailability of the technologies that can help in applying the planning.

The waste of materials can happen along the construction project cycle, and there are many reasons that can cause this waste. During the interviews, each respondent was asked to choose one or more of the most common reasons for the materials waste, which were prepared by the researcher based on the previous studies. Around 68% of the respondents, indicated that the delay in the delivery of the materials is one of the main reasons of the waste in the projects' sites. Around 38% of the respondents indicated that the delay in requesting the materials is one of the main reasons for the waste, while the high percentage of respondents is for those who checked the problems in materials availability as one of the main reasons of the waste, and it is around 76% of the respondents.

Some criteria can be applied to store the materials in the warehouse which makes the materials tracking easier and mitigates the waste of materials. The respondents were asked to choose the most criteria item that must be applied in storing the materials. Around 91% of the respondents indicated that the classification and the order of the materials is one of the most criteria items that must be applied. While the maintenance of the warehouse was selected by around 15% of the respondents, other respondents considered this item not related to the materials management. The following figures show the criteria items provided by the researcher and the percentage of the respondents who selected them.

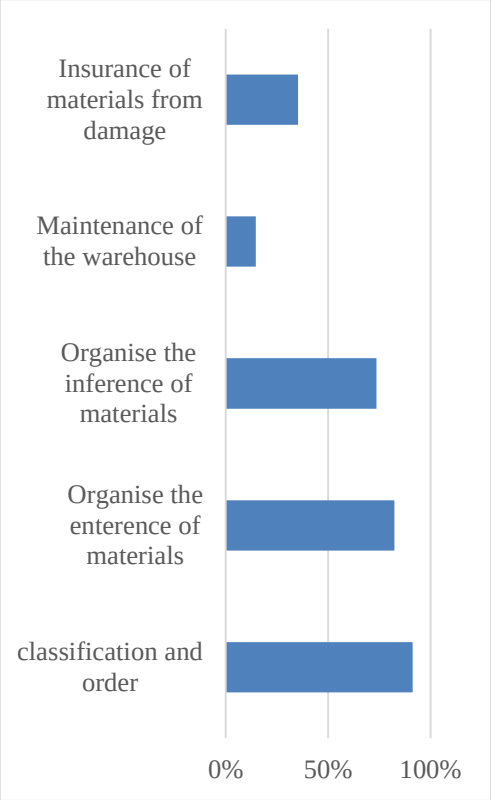

Figure (7): the chart shows the percentage of respondents who checked the criteria item of the materials storing

OBSTACLESONTHE EFFECTIVE MATERIALS MANAGEMENT:

Kasim (2008) divided the materials management into the planning, procurement, logistic, and handling processes of the materials, and those processes aim to use the materials in an effective way. For each phase of the construction project, there is, in parallel, a phase of materials management, which has its obstacles as follows:

1.4 Phase #1: Defining the materials

The management of materials exist along the whole project cycle, from the design phase to the closure phase. While designing the project related to the construction study and the organizing study, the phase of defining the materials starts, which is the first phase of the material management. In this phase, the designer defines the materials with their quantities and specifications. The product of this phase is drawings which clarify the architecture and construction design, in addition to organizing the study. The uncompleted drawings, unclear specifications, the diversity of the materials in terms of quantities and qualities, and the unavailability of some planned materials, are some obstacles to the effective materials management in the defining material's phase. Others are regarding the communication among the stakeholders. The 34 respondents chose the main obstacles, taken into consideration that every respondent chooses more than one obstacle depending on their point of view. The incomplete drawings obstacle was chosen by around 85%, while the least percentage of respondents, 29%, was for the lack of communication with the suppliers.

1.5 Phase #2: Selecting suppliers

Out of the 34 respondents, around 56% checked the incomplete proposal as one of the obstacles on the effective materials management, while around 74% of the same sample chose the uncontrollable bid list as one of those obstacles in the phase of choosing the suppliers, and those two options are under the company responsibility.

1.6 Phase #3: Procurement

This phase includes all the processes started from selecting the suppliers until storing the materials in the warehouse or directly using or handling them in the construction site. With choosing more than one option, the respondents checked the worst obstacles on the material management during the procurement phase. Around 88% of the respondents checked the bad method of storing materials, which is the biggest percentage, and that reflects the high effect of the storage method on the materials management. The delay in delivery date and lack of conformance to requirements have another high percentage of checking respondents, which is around 82%. The least percentage for all options was around 41%

for the respondents who checked the poor communication.

1.7 Phase #4: Implementation (construction)

There are many obstacles in the implementation phase that can lead to a waste in materials or to a delay in the handling of them, which affects the materials management. If the delivered materials' quantities do not match the need of the site, or their quality is not the same as the requirements, the activities will be postponed until the issue has been resolved.

The previous materials tracking has results in the implementation phase, so any waste or delay has its impact on material tracking in this phase. The 34 respondents defined the high impact obstacles on the materials management, and the maximum number of respondents who defined the incorrect quality delivered, who are 30 out of 34 respondents (around 88%), while only around 53% of respondents defined the previous tracking of the materials,and it is the least percentage among the other obstacles during the implementation phase.

1.8 Overview on materials management obstacles in all phases:

As mentioned above, for each phase of materials tracking, there are obstacles that can affect materials management. By taking an overview of all the obstacles, there is a relation between them across the phases; so by comparing the percentages for each obstacle selected, it is possible to define the obstacles which most and least effect restricting the materials tracking. In addition, it is possible to define the differences among the impact of those obstacles on the materials management, as well as defining the phase which has the highest impact obstacles on the materials management. Based on the results of the surveys, the lack of communication with the suppliers in the materials identification phase was selected the least by the respondents of the sample, namely by around 29%. This was during the 'defining materials phase', while the highest percentage of respondents from the research sample selected the obstacle 'incorrect quality of the delivered materials' and 'the method of materials storage'. The following Table 4 shows the arranged obstacles according to the percentages of respondents who selected them as ones of the worst impact obstacles on the materials management:

Table (3): The percentage of checking respondents for each obstacle with its phase

Phase	The obstacles	%
Phase #1: Defining the materials	Lack of communication with suppliers	29%
Phase #3: Procurement	Poor communication	41%
Phase #3: Procurement	Theft	44%
Phase #3: Procurement	Buy the used materials	44%
Phase #1: Defining the materials	Lack of communication between stakeholders	47%
Phase #1: Defining the materials	No determining of what and when materials needed	47%
Phase #3: Procurement	Damage of the delivered material	53%
Phase #3: Procurement	Unavailability of required material	53%
Phase #4: Implementation	Time needed to keep track of materials	53%
Phase #2: Selecting suppliers	Incomplete proposal	56%
Phase #3: Procurement	Competition in the prices among the suppliers	59%
Phase #4: Implementation	Loss of material	59%
Phase #1: Defining the materials	Undefined scope	62%
Phase #4: Implementation	Bad storage conditions of materials	65%
Phase #4: Implementation	Poor communication	68%
Phase #2: Selecting suppliers	Time spent in investigating non-qualified suppliers	71%
Phase #1: Defining the materials	No standards for the specifications	74%
Phase #2: Selecting suppliers	Uncontrollable bid list	74%
Phase #3: Procurement	Late in bid process	74%
Phase #1: Defining the materials	Lack of conformance to requirements	76%
Phase #1: Defining the materials	Difference between plans and specification	79%
Phase #3: Procurement	Unavailability of good quality	79%
Phase #3: Procurement	Unrealistic delivery date	82%
Phase #3: Procurement	Lack of conformance to requirements	82%
Phase #4: Implementation	Incorrect sizes of delivered materials	82%
Phase #1: Defining the materials	Incomplete drawings	85%
Phase #4: Implementation	Incorrect type of delivered materials	85%
Phase #3: Procurement	Bad storage conditions of materials	88%
Phase #4: Implementation	Incorrect quality of delivered materials	88%

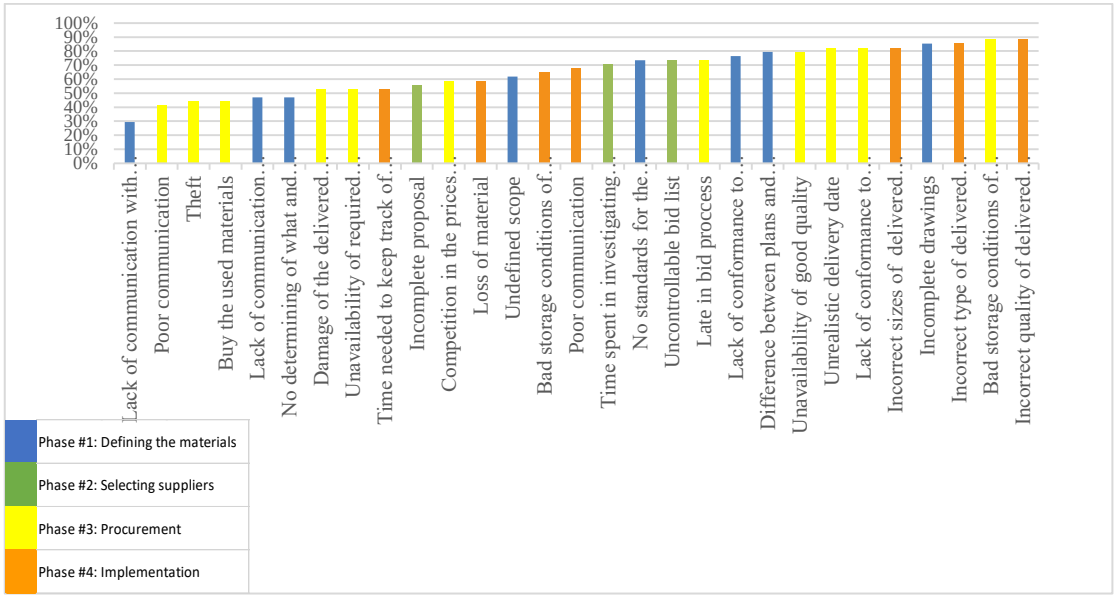

Figure (8): The chart shows the percentage of respondents for each obstacle

The percentage of the obstacle is represented by the number of respondents, who have checked this obstacle as one of the worst obstacles impacts effective materials management, out of all the respondents. Thus, this percentage reflects the level of the obstacle's impact on the materials management depending on the opinion of the respondents.

By the visual note on the previous Figure 8, the implementation and the procurement phases have the highest impact on the effective materials management, while the selection of suppliers' phase has the least impact.

By statistic way in defining the impact of the phases on the materials management, there were two factors to define the impact: Each obstacle belongs to a different phase, the phase which has a greater number of obstacles that have higher percentages, has a high impact on the materials management.

The number of obstacles options given to the respondents to choose the most effective one according to his/her opinion, since the options of the obstacles for each phase were defined depending on the previous studies, so there has been a difference between the phases regarding the number of the obstacles in them. Each phase has a different number of obstacles than the other, and that gives each one a different weight, so the one which has a bigger number of obstacles, has a higher impact, which means a higher weight.

According to this logic, the Table 5 shows how to calculate the average percentage of impact for each phase depending on its obstacles and the percentage of respondents defining each one.

Table (4): The average percentage of checking respondents per each phase

The phase	Phase #1: Defining the materials	Phase #2: Selecting suppliers	Phase #3: Procurement	Phase #4: Implementation
Av[(1)]	63%	67%	64%	71%

As it is shown in the previous table, the average percentage of the implementation (construction) phase is the highest one, which is around 71%. However, for each phase there is a weight calculated according to the number of the obstacles provided to the respondents to choose from. The Table 6 shows the effective average percentage by entering the effect of the weight (the number of obstacles for each phase) on the calculation of the average percentage, which means the effective impact of the phase obstacles on the materials management:

Table (4): The effective average percentage of checking respondents (the effective impact of the phase)

The phase	Phase #1: Defining the materials	Phase #2: Selecting suppliers	Phase #3: Procurement	Phase #4: Implementation	Total
W[(2)]	0.28	0.10	0.38	0.24	1
Av[(1)]	63%	67%	64%	71%	-
Av_{eff}[(3)]	17%	7%	24%	17%	-

[(1)] Av: Average percentage of checking respondents per each phase.
[(2)] W: Weight=Number of obstacles / Total number of obstacles suggested by the researcher.
[(3)] Aveff: Effective average percentage = Weight * Average percentage.

According to the table, the effective percentage of the procurement phase is the highest one, so it has the obstacles with the higher impact on the materials management, while the selecting suppliers phase has the lowest impact.

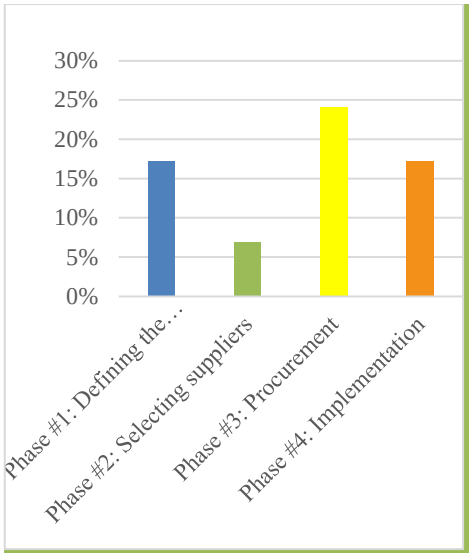

Figure (9): The chart shows the effective impact of each phase on the materials management

The last process is done to know the impact of obstacles in each phase on the materials management and the importance of monitoring and tracking materials in each phase to mitigate the effect of the obstacles belonging to it.

RESEARCHERS NOTES AND OBSERVATIONS:

To have a clear view of the reality of the projects in Syria, the researcher tried to take some notes from the assessed projects and the engineering companies and offices which were visited during information collection. The notes are in two parts, the first one is related to the warehouse and the other part is related to the site. Out of 46 projects, there are notes for 43 ones of them.

Regarding the warehouses, warehouses are accessible in around 79% of the projects. In 30 out of 43 assessed projects, which is 70%, there is a classification of the materials, and in 28 of them which is 65%, there is the organizing of the materials entering the warehouse. There is a double of dealing in 47% of the assessed projects.

In around 30% of those projects, there is regular maintenance of the warehouse, and in around 58% of them, there is the protection of materials from damage. Around 81% of the projects have an adequate loading area, and around 49% of them have an adequate storage area.

Regarding the sites, the sites are accessible for around 70% of the assessed projects. The construction sites were narrow for the works in around 49% of the projects, and it is vast and extended in around 49% of the projects. There were a large number of workers in around 77% of the projects (The highest percentage) and a large number of equipment in around 35% of them, there were special tracks for materials in around 42% of the projects and other special tracks for the equipment in around 65% of the same projects.

The mentioned percentages above are representing the observation of the researcher and the opinion of the respondent about his / her own project.

DEALING WITH THE SUPPLIERS

As the suppliers are one of the stakeholders, and their performance also affect the effective materials management; Therefore, after studying the reality of the construction projects depending on the projects frame, and the feedback of the engineers' frame, the next step was to study the reality of the construction projects' regarding to the dealing with suppliers. The respondents give their feedback about the suppliers' work regarding the criteria of selecting them, the challenges in dealing with them, and the restrictions and obstacles of their work, and whether they have dealt with them before during their previous construction projects. Depending on those responses, the

researcher will define the affect of suppliers' work on materials tracking, thus, on the materials management.

The project survey includes three open-ended questions as the following:

1.9 What are the criteria of selecting the suppliers?

32 out of 34 respondents responded to this question. around 74% of the targeted sample indicated that the good specifications of the materials provided by the suppliers are one of the criteria to select the supplier. They confirmed that the materials provided by the supplier must meet the ISO quality conditions and be more sustainable in addition to provide the materials with the written specifications. "The good quality of materials and matching required specifications are the first criteria in selecting the supplier, and more important than the materials cost.", one of the respondents said.

The supplier must be fast in providing materials, for around 38% of the sample and around 9% confirmed that the supplier has more opportunity to be selected if he gives a warranty for his/her materials. The cost is one of the selection criteria for around 47% of the sample, while only around 2% of the respondents indicated the reliability of the suppliers as one of the suppliers' selection criteria.

According to the respondents, around 18% preferred the suppliers who commit to the date of supplying materials depending on the supply contract with the engineering company. One of the main obstacles of effective materials management is the unavailability of some materials in the market, as the economic crisis in Syria has led to losing some materials from the market. Also, around 18% of the respondents preferred the supplier who has experience in supplying materials for construction projects, especially for the huge and complicated ones, and around 6% added that the supplier has to have certification documents of experience, in addition to having a good reputation in the market.

There are some criteria and notes added by the suppliers, as the supplier has to be specialized in one materials type, which gives more privilege to be selected, not only as a vendor. Other ones indicated that the following list of selection criteria: the supplier's method of receiving money from customers, the distance between the supplier and the construction site or the warehouse, the way of dealing with customers, and concern in beauty part of sold materials, depending on the type of the materials. One of the respondents confirmed that the selection relies on the type of the construction project and the design requirements.

The most mentioned criteria by the respondents is the supplier's materials specifications and quality, which is mentioned by around 74% of them, while the supplier's reliability is mentioned by around 3% of the respondents only.

1.10 What are the potential problems and challenges in dealing with the suppliers?

31 out of 34 respondents, responded to this question. Around 71% of the targeted sample indicated that some suppliers provide the materials in different specifications and quality to mitigate their expenses. Delivering materials to construction sites on time is one of the main concerns for the project engineers. around 62% of all respondents confirmed that it is not acceptable from the supplier, if the supplier is not committed to delivering the materials on time, because that will affect the project schedule and delay paying the financial receivables by the project management. Also, the difference between the delivered materials quantities and the required ones is another problem with the supplier according to around 15% of the respondents. One of the respondents indicated that the negative way is used by some suppliers in dealing with their customers is another issue.

The supplier performance is not always the cause of the problem. Sometimes the changes in the prices of materials, which was indicated by around 12%, in addition to the

unavailability of the materials, are other concerns for the suppliers and the engineering companies alike. This is because the supplier cannot deliver the planned materials by the companies, or the materials with the same planned quality or types which the supplier has committed to deliver, due to the unavailability of the same planned materials type or quality in the markets.

Around 18% of all respondents indicated other problems with the suppliers such as the way of payment and misunderstandings of the requirements of the materials. One of the respondents thought that relying on the suppliers without informing the contractor is an issue. Another respondent indicated that some suppliers do not commit to the warehousing and transportation standards.

The suppliers' way of dealing with customers is mentioned by around 3% of the respondents which is the lowest percentage among the other mentioned problems. While the difference between the delivered materials and the required ones regarding the specifications and the quality is mentioned by around 71% of the respondents.

1.11 What are the restrictions and obstacles on the suppliers' work?

Also, 31 out of 34 respondents, responded to this question. Around 50% of the respondents indicated that the first issue suppliers can face is the availability of the planned materials in the markets as some materials are unavailable in the market after the supplier signs the contract to supply the materials. The method and the issue of paying money to the supplier restricts his/her work, when delays occur in receiving payment. Around 9% confirmed that the suppliers suffer from delays in receiving payment from the companies and the delay is related to the procurement process of the company. Also, around 9% indicated that the suppliers, after contracts are signed, cannot provide the materials with the same specifications to meet the plan. One of the respondents claimed that using the papers in the work processes in the engineering and the suppliers' companies, restricts the work and causes delays in the implementation for the companies and the supplier in receiving payment. Some procurement procedures can cause delays in paying the suppliers, as using the bid is different from using the direct paying, and depending on the procurement procedure and the time needed to finalize it, the price of some materials may not be appropriate for their specifications or these prices may change. This was indicated by around 15%.

According to around 9% of the respondents, the distance between the supplier company and the warehouse is another restriction for supplying materials to the project site. The cost of transportation and the fees are restricting the supplier's work for 2 out of all the respondents. Around 18% indicated that the suppliers have to pay more fees in some cases, due to delays caused by themselves or by external circumstances.

The availability of the materials was indicated by around 50% of the respondents as one of the obstacles to the suppliers' work, while using papers, transportation and the taxes on the materials supplied by the suppliers were indicated by around 3% of the respondents as obstacles. 18% of the respondents confirmed that the fees related to the delay of delivering materials are one of the obstacles.

CONCLUSION

Construction projects in Syria suffer from relying on traditional methods, and this reflects on the materials management, especially on the materials tracking. The Syrian conflict has increased the obstacles to improve the materials management and developing the used tools in tracking the materials, so in most of the assessed projects by the study, which is completed or ongoing at the time of the research, the general communication among the project stakeholders is verbal, and Excel is the most used in the management of those projects, while the other computer programs as primavera are less used in the construction projects.

According to the findings of the research, the variety of materials, the vastness of the project, the number of workers, and the accurate site planning are the main factors that determine the type of the materials management. While the distance between the project site and inventory are less important factors, as most of the projects have warehouses in their sites. The security of the warehouse is applied to most of the assessed projects, but it is limited to protect the materials from theft.

The findings show that the most impactful obstacle on the materials management is the incorrect quality of the delivered materials, while the least impactful obstacle on the construction project is the lack of good communication with the supplier.

Based on the research, the procurement phase is the highest affect phase on the materials management, as it includes most of the effect-obstacles According to the responses, in most of the construction projects, there is checking of the received materials, which is a part of the procurement phase, in spite of the fewer differences happening between the required materials and the delivered ones related to the quantity and the quality.

In general, the materials needed in the traditional construction projects are available, but the problem in providing the materials started appearing with the increasing complexity of the projects. Also, the lack of planning for the required materials increases the cases of additional materials requests, especially in the middle of the project period, at most of the construction projects.

The methods of receiving the materials and storing them in Syrian construction projects are still traditional and there are no technologies used in most of the construction works in Syria especially in the sites. The process of organizing receiving the materials in the warehouses is the most needed related to the materials storage. The percentage of materials waste in most of the construction projects is between around 20% to 30%, and according to the respondents, the main reasons of the materials waste is the unavailability of the materials, which reflect on the planning.

The researcher's notes of the assessed projects show that the existence of a lot of workers in the site is the most factor affecting the construction sites, while the area specified for uploading and unloading is the most affecting factor on the warehouse work.

The respondents gave their feedback related to the supplier's work to define how this can affect the effective materials management, and most of them think that the materials specification is an important point to be taken into consideration in selecting the supplier. Less of them consider the supplier's reliability is important. Related to the main problems with the suppliers, most of them think that the difference between the delivered materials and the required ones is one of the main problems. While fewer respondents think that supplier’s bad behaviour in dealing with his/her customers is an issue, when it comes to work with them. The availability of the materials is the most mentioned reasons by the respondents for obstacles to the supplier's work while the taxes and transportation is the least mentioned one.

The study clarifies the importance of adjust the processes conducted in procurement phase, that is the highest affect phase on the materials management. Also, all the stakeholders including the suppliers are responsible to participate in that, and each of them has their important role. This paper opens the door to further researches about the importance of automating the materials tracking process in all phases, through creating a system that can gather all the information related to the materials, and give updates to track materials and take decisions in real-time.

REFRENCES

Bell, Lansford C., and Stukhart, George. (1986). Attributes of material management systems. A.S.CE Journal of Construction Engineering & Management, Vol. 112, No.1, pp. 14-21.

Dos Santos, Aguinaldo, Powell, James A., and Sarshar, Marjan. (2002). Evolution of management theory: The case of production management in construction. Management Decision journal, Bingley, UK.

Garcia-Lopez, Nelly P., and Fischer, Martin. (2014). A system to track work progress at construction jobsites. Proceedings of IIE Annual Conference. p. 3403, Institute of Industrial and Systems Engineers (IISE)

Ghanem, A. A., AbdelRazig, Y. A., and Mahdi, S. M. (2008). Evaluation of a real time construction project progress tracking. Sustainable Development through Culture and Innovation Sustainable Development through Culture and Innovation, pp. 771-780.

Griffith, Alan and Watson, Paul. (2004). Construction management: Principles and practices. Macmillan International Higher Education, Palgrave MacMillan, New York, USA.

Jimoh, R. A. (2012). Improving site management practices in the Nigerian construction industry: The builders' perspective. Ethiopian Journal of Environmental Studies and Management EJESM, 5, no. 4, pp. 366-372, Bahir Dar University, Ethiopia.

Kasim, Narimah, Liwan, Siti Radziah, Shamsuddin, Alina, Zainal, Rozlin, and Che Kamaruddin, Naadira. (2012). Improving on-site materials tracking for inventory management in construction projects. Proceedings International Conference of Technology Management, Business and Entrepreneurship 2012 (ICTMBE2012), December 18th – 19th. pp. 447 – 452, Renaissance Hotel, Melaka, Malaysia.

Kasim, Narimah B. (2008). Improving materials management on construction projects. PhD. Thesis, Loughborough University, Loughborough, United Kingdom.

Nasr, Elhami, Shehab, Tariq, and Vlad, Ana (2013). Tracking systems in construction: Applications and comparisons. Proceedings of 49th ASC Annual International Conference, pp. 9-13, California State University, Long Beach.

Ogunlana, Stephen O., Promkuntong, Krit., and Jearkjirm, Vithool. (1996). Construction delays in a fast-growing economy: Comparing Thailand with other economies. International Journal of Project Management, Vol. 14, No. 1, pp. 37-45

Patel, Khyomesh V. and Vyas, Chetna M. (2011). Construction materials management on project sites. Proceedings of National Conference on Recent Trends in Engineering & Technology, 2011 May, pp. 1-5.

Zaha, Ahmed. (2017). The impact of materials management on construction project delivery in Maldives. MASTER dissertation, Universiti Tunku Abdul Rahman, Jaya, Malaysia.

Bamisile A. (2004). Building production management: The professionals instruction manual, Ethiopian Journal of Environmental Studies and Management EJESM, Foresight Press Limited, Lagos, Nijeria