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FACTORS CAUSING DELAY OF MATERIALS DELIVERY IN CONSTRUCTION INDUSTRY IN EASTERN PROVINCE OF SAUDI ARABIA

Alshibani, Adel^{1,2} Eltourkey, Mahmoud^{1,3} Elmaghraby, Bahaa Eldin^{1,4}

¹ King Fahd University of Petroleum and Minerals, Saudi Arabia

² alshibani@kfupm.edu.sa

³ eltourkey.mahmoud@gmail.com

⁴ bahaaelmaghraby@gmail.com

Abstract: One of the main causes of project schedule delay is material delivery as it plays a significant role in construction and effects profitability of all parties involved in the project. This paper introduces study conducted to investigate, identify, and rank the most key factors causing material delivery delays in construction industry in Eastern Province in Saudi Arabia. Factors are assessed and ranked after collecting the data from the respondents using a web-based and paper questionnaire. Forty-two responses were gathered from experts in various positions in construction industry in Eastern Province of Saudi Arabia. The study found that the most important factors that cause delay of building material delivery in construction industry in Saudi Arabia are late issuance of purchase order, late adoption of material, Delays in approving shop drawings, Late issuance of invoices to contractor, Late issuance of supplier payment. The paper is original in the sense that although many researches have been conducted to name causes of construction schedule delay, extremely limited research conducted to identify causes behind delay in building material delivery. In addition, the areas of knowledge and practice covered in the identified factors were distributed and not available in one source. The identified factors are derived from personal interviews with selected project managers, project engineers, construction supervisors and the others from distinct positions in project department and from the relevant literature.

1 INTRODUCTION

Project schedule is one of the most important constraints to deliver a successful project that must be taken into consideration throughout the project life cycle. As, it is the driving force to fulfill the project before the scheduled due date, within the budget and in accordance with the specifications. The literature reveals that a common incident that occurs in almost all construction projects is time delay of the whole project. The main cause of project schedule delay is material delivery as it plays a vital role in the construction and effects the profitability of all parties involved in the project. The literature suggests that an enormous number of researchers have showed a distinct number of factors that directly affect delay of building material delivery in numerous building projects. That affect the contractor's profile and the owner economy, and it maybe affects the overall economy of the country as well. It is clear that there is a need to understand the effect of such factors in order to overcome their negative impact on project performance.

For contractors to enlarge their revenue, they have to comprehend the aspects that will lead to the success of their projects and their own reputation. The delay of material delivery means the deficiency in completing the requirement of the project within the scheduled time which may result in 1) Rising of the project cost; 2) Completing the project after its due date; 3) Disrupting in the learning curve; 4) losing in productivity rate;

5) Disputing and conflicts between the parties of the contract; and 6) terminating of the contract and losing of trust between the owner and the contractor (Aziz 2013).

The main aim of this research is to identify and rank the most critical factors causing delay of buildings material delivery by owner or his consultant, contractor, or supplier. The research is based on the feedback gathered from experienced individuals in construction field such as project engineers, project managers, suppliers, procurement officers, and supervisors in eastern province in Saudi Arabia. The findings of this research can be utilized not only in the eastern province but also in the entire country. Moreover, the finding can aid any participant in the industry to evolve a better understanding of factors delaying the material delivery and present high standard guidelines for productive solutions. In literature review section, several factors causing the delay of material delivery have been found. The succeeding sections show research methodology, literature review, research objectives, discussion, and results of causes. Finally, the conclusions with some recommendations to overcome such factors are highlighted.

The objectives of this study can be summarized as follow:

- Conducting comprehensive literature review to identify factors causing the delay of building materials delivery.
- Holding interviews with local experts in deferent aspects in construction industry in order to identify additional factors causing the delay of the building materials delivery based on local experience.
- Designing a web-based and paper-based questionnaire to assess the recognized factors.
- Distributing the questionnaire to the experts to get their opinion that formed through their experience.
- Analyzing the collected data to rank the factors
- Concluding and providing some recommendations.

2 RESEARCH PROBLEM AND SIGNIFICANCE OF THE RESEARCH

Completing the project without schedule delay or/ and cost overrun is the main aim of the project management team. Literature review shows that intensive research has been carried out to identify the causes of schedule delay and/ or cost overrun, however not much research is conducted to deeply study one of the main causes of project schedule delay which is the delay of material delivery. The objectives of this research are to 1) Identify the main critical causes of delay of buildings material delivery; 2) Rank the identified factors using Relative Important Index (RII); and 3) Demonstrate and discuss each factor in each category showing their importance in project delay; and 4) introduce recommendations that widen the perspective of all personnel in construction industry about the factors causing the delay of material delivery. These recommendations can assist in preparing more realistic schedule and avoiding costly project delay.

3 PREVIOUS STUDIES

An extensive review of literature has highlighted that delay in construction projects is a major issue leading to adverse effects on the project. A time delay could lead to increased costs, loss in productivity, loss of profit and legal disputes between owners and contractors (Owalabi, et al. 2014) (Daba and Pitroda 2008). Several factors can cause a delay of project schedule and materials delivery is one of the key factors indicated in a number of previous studies. Many researchers have proved in their studies that material is one of the primary causes of delay in construction projects all over the world. For instance, a survey study in Malaysia identified the factors affecting construction labour productivity in Malaysian residential projects. The study found that the material shortage was the most important and most frequent factor among others, which cause delayed construction projects (Abdul Kadir, et al. 2005). Furthermore, (Assaf and Al-Hejji, Causes of delay in large construction projects 2006) performed a survey to investigate the factors causing project delay in Saudi Arabia. The study identified 73 causes of schedule delay. 7 of them are related to building material delivery problems include (lack of availability of construction material in the market, change order in material type, specification and quality during construction, damage of stored material on site while they are needed directly, delay in manufacturing and procurement special building materials & taking so much time in the choice of finishing materials due to variety of types in the market. In addition, a similar

study was conducted using relative importance index to identify factors, which cause delay in construction projects after the Egyptian revolution. The study found that shortage of material is among the top ranked factors among others as the leading causes of delay in construction projects (Aziz 2013).

The situation in Saudi Arabia is similar and a study by (Assaf, Al-Khalil and Al-Hazmi, Causes of Delay in Large Building Construction Projects 1995) outline the causes of delay in large construction building projects in Saudi Arabia and its ranking. A survey of random contractors, Architecture/engineering firms, and owners in the Eastern Province was undertaken. The survey included 56 causes of delay and the respondents were asked to rank their level of importance. The result showed that the contractors and architectural engineers ranked the material group high, and the owners ranked it low. As they found that, this result is mostly due to the delay factor of the special manufacturing of building materials outside of Saudi Arabia, which has a large impact on the construction project.

Materials play a major role in determining the delivery of a project on time. However as noted in the studies, material delay is common. While material delay has been noted as a major factor in delay of projects the factors, which result in material delay, have not been studied and yet identified in Saudi Arabia. A number of factors as identified in literature can cause material delay. For example, (Owalabi, et al. 2014) conducted a survey study with the goal inspecting the reasons and results of delay in building construction project duration. They found 15 significant factors among which fluctuation in prices of building materials is one of the most important factors. Further similar studies have identified in different locations around the world the different factors leading to material delay in construction projects including lack of storage/offloading space, delay in delivery due to transportation delays/late material supply, wrong material delivered which doesn't match specifications, change orders calling for change in type of material to be used, material damage (Spillane, et al. 2013) (Yan, Xu and Han 2015) (Daba and Pitroda 2008).

Many researchers have investigated the causes of material delay and developed and proposed possible solutions to overcome the delay. For example, (Sayed, Ali and Ahmed 2017) have proposed that new methods are needed in Egypt to assure timely material delivery to project sites. They proposed a Just-in-Time (JIT) management system, which optimizes the time, required for material delivery, and studied the feasibility of implementing such a system in Egypt through a case study.

Improper material management is one of the main issues, which results in delay. Materials management is a combined procedure where people, technology, organizations, and processes utilized to efficiently identify, quantify, acquire, transport, receive, store and use of materials across the life cycle of a capital project. The goal of materials management is to guarantee the right quality and quantity of materials are available when needed (Caldas, et al. 2014). Material management practices were studied by (Thomas, Sanvido and Sanders 1989) and they found if proper material management practices are in place will lead to a benefit cost ratio of 5.7. A number of reasons could be responsible for improper material management. (Ren, Anumba and Tah 2011) studied the problems that face construction projects related to material management starting from material planning, ordering, handling, and distribution, receiving and storing, site usage and monitoring. They identified poor material management as a huge factor that has negative effects on labour productivity, cost overrun, and delays. Also, materials management becomes more complicated as the project complexity increase, so they presented a Radio Frequency Identification System (RFID) assisted construction material management system which is developed to block these problems. This advanced technology aids project parties to gather all the information about material from ordering day to the day of use. This system is widely used around the world by construction firms and has proven its efficiency for improving material management process. In addition, existing methods of materials management was studied in Nigeria by conducting a survey of all the construction sector stakeholders. It was found that the currently purchasing of materials, materials planning method and transportation of materials are the most utilized ways of materials management while the malpractices include inadequate work planning and scheduling, delayed payments and vandalism. The study highlighted that ineffective materials management results in project delay which ultimately leads to increased cost and time f project and decreased quality and productivity. It was stressed that proper materials management could be done by administration of sites (Arijeloye and Akinradewo 2016). A similar study was done in UK by (Dawood n.d.) and it was found that currently improper material management practices takes place due to decisions being made subjectively. As a result, late ordering of materials was a common error as well as ordering

higher amounts of material than required which resulted in waste. Furthermore, a more proactive approach was proposed by (Ala-Risku and Kärkkäinen 2006) that contains of a tracking-based approach for building inventory transparency for short-term supply chains, and a pro-active material delivery model for the materials for specific project tasks.

It can be summed that materials delay is one of the leading and contributing significantly towards the timely delivery of construction projects globally. However, the factors causing delay of material delivery differ from country to country. For example, (Rahman, et al. 2017) found causes in Brunei Darussalam that result in shortage of material including availability of construction material and poor procurement and management system. A similar study is required for Saudi Arabia that is the objective of this study to investigate the causes of delay in material delivery in Saudi Arabia. The findings from such a study could ultimately have an impact on contractors in the country in optimizing their material management processes to ensure timely delivery of projects that will eventually save time and thus costs.

3.1 Identifying Factors Causing Delay of Material Delivery

As described above, several researchers examined a series of factors causing delay of buildings material delivery. Some factors are obtained from conducted interviews and others are from the researchers' point of view and brain storming. Table 1 presents the identified factors along with the identifying source.

4 RESEARCH METHODOLOGY

The methodology applied in this research consists of four stages. The aim of the first stage is the identification of factors causing delay of material delivery in buildings projects. In this stage, a comprehensive literature review and interviews with local experts were conducted which resulted in identifying 25 factors that cause the delay of material delivery. In the second stage and after the identification of these factors, a questionnaire was designed and distributed to experienced parties involved in construction projects in Eastern province of Saudi Arabia including project engineers, project managers, procurement officer, office managers, and technical office engineers. The purpose of the questionnaire is to rank the importance of the identified factors. Having the questionnaire ended and responses received, the fourth stage started by analyzing the gathered information through the questionnaire and sorting them from the most important factors to the least important using Relative Important Index. The most critical five factors were emphasized, then the research is concluded by suggesting some recommendations to different parties involved in the construction to avoid or minimize the effect of such causes in future projects.



Figure 1: Research Methodology

Table 1: Factors causing the delay of building material delivery

	Potential Factor	Sources
1	Late issuance of purchase order (Not following the project plan)	(Aziz 2013) (Assaf and Al-Hejji, Causes of delay in large construction projects 2006) (Owalabi, et al. 2014)
2	Late adoption of materials	(Assaf, Al-Khalil and Al-Hazmi, Causes of Delay in Large Building Construction Projects 1995) (Assaf and Al-Hejji, Causes of delay in large construction projects 2006) (Owalabi, et al. 2014)
3	Delay in approving the shop drawings	(Aziz 2013)
4	Late issuance of invoices to the contractor	Experts
5	Late issuance of supplier payment	Experts
6	Availability of the material in the markets	(Assaf, Al-Khalil and Al-Hazmi, Causes of Delay in Large Building Construction Projects 1995) (Assaf and Al-Hejji, Causes of delay in large construction projects 2006) (Owalabi, et al. 2014)
7	Lack of competence of the technical staff of the contractor	(Owalabi, et al. 2014)
8	The permissions for the material to access the site (from the Owner)	Experts
9	The permissions for the material to access the site (from contractor)	Experts
10	Municipal laws	Experts
11	The late payment of the workers	Experts
12	Border Customs	(Assaf, Al-Khalil and Al-Hazmi, Causes of Delay in Large Building Construction Projects 1995)
13	Poor coordination between the contractor's departments to issue the materials	Experts
14	Traffic laws	Experts
15	Delayed departure order from stores	Experts
16	Poor material storage techniques	(Assaf, Al-Khalil and Al-Hazmi, Causes of Delay in Large Building Construction Projects 1995) (Assaf and Al-Hejji, Causes of delay in large construction projects 2006) (Spillane, et al. 2013)
17	The fluctuation of material price	Experts
18	Lack of presence on a permanent basis at the project site	Experts
19	Poor material usage techniques	Experts
20	The conditions of the delivery trucks	Experts
21	Inflation	Experts
22	Compelling reasons (unforeseen weather events)	Experts
23	Weather conditions (related to the transportation)	(Owalabi, et al. 2014)
24	Failure to provide equipment for loading and unloading vehicles	Experts
25	Weather conditions (related to the material properties)	Experts

5 ASSESSMENT OF FACTORS CAUSING DELAY IN MATERIAL DELIVERY

The influenced factors obtained from the literature are combined with that drawn through interviewing of four local experts. The combination has resulted in identifying of 25 factors. Through a web-based questionnaire, 42 responses were gathered, and the identified factors were ranked. The responses consist of 15 project managers, 21 project engineers, 2 supervisors, 3 suppliers, and a procurement Officer. This is presented in Table 2. This section describes the assessment of level of importance for each of the 25 identified factors causing delay of building materials delivery in Saudi Arabia.

Table 2: Respondents' Positions

Position	Respondents
Project Manager	15
Project Engineer	21
Supervisor	2
Supplier	3
Procurement Officer	1

5.1 Characteristics of the Respondents

The web-based questionnaire developed in this study focused on obtaining responses from many professionals in Saudi construction industry located in the Eastern Province. The responses gathered from different construction organization with variety of sizes and from several professionals with a wide range of experience. More than 9% of the gathered respondents have experience of more than 30 years as illustrated in Table 3. In addition, 35 % the respondents are holding a position of project managers and 50 % of the respondents is holding a position of project engineer.

Table 3: Practical Experience of the Respondents

Experience (Year)	Respondents	Percentage
More than 30	4	9.52
20-29	3	7.14
10-19	16	38.10
5-9	8	19.05
Less than 5	11	26.19

5.2 Relative Importance of the Identified Factors

The gathered responses were assessed, tabulated, and the relative importance index (RII) method was used to determine the relative importance of the identified factors. This deterministic method is selected for the following reasons:

- It is easy to be understood and used by all levels of respondents regardless of their level of education
- The questionnaire involves large number of factors, which makes the application of RII effective.

Using equation 1 the RII were calculated:

$$[1] \quad RII = \frac{n_1 \times 0 + n_2 \times 25 + n_3 \times 50 + n_4 \times 75 + n_5 \times 100}{(n_1 + n_2 + n_3 + n_4 + n_5)}$$

Where RII stands for "Relative Importance Index);

n_i = the number of voices for the i^{th} choice

The regular intervals are utilized in the scaling of this system. Each interval is allocated for particular weight, that is ranging from "extremely important" to being "not important". Respondents ranked the various factors using their experience in building industry with a 5-grade scale. Extremely important for most influencing

factors, very important in second position, followed by medium important, minor important and finally not important as a very low or no significance in influencing the delay of building material delivery. The factors are started from zero (0) for “Not important” choice and end with a hundred (100) for the “extremely important” choice, passing through (25) for “minor important”, 50 for the “medium important” choice and 75 for “very important” choice. After collecting the answers from the respondents, the calculations were done to get every cause a score. The causes are ranked based on the data shown in Table 4.

Table 4: The Causes of the Delay in the Material Delivery Ranking

Rank	Potential Factor	Score
1	Late issuance of purchase order (Not following the project plan)	89.29
2	Late adoption of materials	88.69
3	Delay in approving the shop drawings	83.33
4	Late issuance of invoices to the contractor	82.74
5	Late issuance of supplier payment	82.74
6	Availability of the material in the markets	75
7	Lack of competence of the technical staff of the contractor	74.4
8	The permissions for the material to access the site (from the Owner)	73.81
9	The permissions for the material to access the site (from contractor)	71.43
10	Municipal laws	64.29
11	The late payment of the workers	63.69
12	Border Customs	63.69
13	Poor coordination between the contractor's departments to issue the materials	62.5
14	Traffic laws	61.31
15	Delayed departure order from stores	61.31
16	Poor material storage techniques	60.12
17	The fluctuation of material price	59.52
18	Lack of presence on a permanent basis at the project site	58.93
19	Poor material usage techniques	58.33
20	The conditions of the delivery trucks	58.33
21	Inflation	58.33
22	Compelling reasons (unforeseen weather events)	55.95
23	Weather conditions (related to the transportation)	54.76
24	Failure to provide equipment for loading and unloading vehicles	53.57
25	Weather conditions (related to the material properties)	49.4

5.3 Influencing Factors

The causes of the delays in the material delivery in Saudi Arabia have been examined from more than one perspective to end up with the results. The respondents ranked the most influencing factors based on their personal experience. As presented in Table 8, the top five factors ranked by the respondent are “Late issuance of purchase order”, “Late adoption of materials”, “Delay in approving the shop drawings”, “Late issuance of invoices to the contractor”, “Late issuance of supplier payment”. Table 8 shows the ranking or the causes of the delay in the material delivery. It can be illustrated from the table that the participants choose “The late issuance of the purchase order or (Not following the project plan)” as the most important factor of the material delivery delay. Discussion of the top 5 factors is as follows:

- The late issuance of the purchase order or (Not following the project plan)

Following the project plan is the hidden secret to finishing the project successfully on time. So, if it is not followed the contractor should be waiting for a lot of problems and pressure as the load of the day will be moved to the next day beside the load already assigned in that day. That will result in moving some other loads to other days that process will result in continuous delays in the project activities. As purchasing, the material is an activity that affects another activity in the project so that it could elongate the total duration of the project.

- Late adoption of the material

The materials used in the project should be either ordered from the owner by specific brand and number or name or only the specification or the function are mentioned and then the owner or his representative adopt a material from the contractor's choice. In the second case, the adoption process may take a long time that will affect the activity duration or its start time.

- Delay in approving the shop drawings

To buy a material it should be well specified and the best way to reach the most details for the material and its place in the project. Those drawings should be adopted by the owner or his representative to avoid material refuse, or to move the risk from the contractor's solder to the owner's.

- Late issuance of the invoices to the contractor

Purchasing the materials sometimes done by the owner, but mostly it is one of the contractor's responsibilities. The contractor should be aware when he should buy the materials, to match the project plan and coordinate the materials in the site, sometimes he is planning to purchase the material in some specific time, but he cannot because of the shortage of money. One of the causes of this shortage that the owner did not pay the previous invoice or invoices that interrupt the contractor's cash flow.

- Late issuance of the supplier payment

To purchase the material from the supplier he should be paid. In some types of materials, the payment is before receiving the material or at the same time of the submission. On the other hand, many of the materials in the construction industry could be even used not only received before the supplier receive its total cost. The last case is the one has some problems with the payments and the supplier sometimes reject to give the contractor any material due to the late payment to ensure he will get his receivables.

6 RECOMMENDATIONS

According to the information gathered and discussed above, some recommendations can be provided in order to decrease the time delay of material delivery caused by the factors mentioned before.

6.1 For Owner

The following recommendations are for the owner or any of his representatives:

1. The adoption of material specifications should be fast enough in order for the contractor to accelerate the purchasing order;
2. The payment of the contractor's invoices should be made on time as this behaviour will interact with the contractor's cash flow creating time delay for the whole project
3. The approving of shop drawings provided by the contractor should be as soon as possible from the time the owner receives them. This could delay the entire project, as they are a crucial step in any construction project.

6.2 For Contractor

Recommendations for the contractor side are as follows"

1. The purchasing order of the material should be issued in time as per the schedule. The late issue can create a huge discrepancy between the as planned and the as-built schedules;
2. Increase the connection between different departments that are responsible for securing the building material of the ongoing projects;
3. Decrease the delay in issuance the invoices to the supplier. As this may force the supplier to delay the material delivery as his cash flow is affected. According to experienced personnel, these acts can lengthen the project duration weeks or months.

6.3 Other Recommendation

Furthermore, some general recommendation regarding the transportation and dealing with the suppliers are as follows;

1. Municipal Laws should be taken in consideration during the loading of materials to the truck and the conditions of the delivering truck. These may lead to delaying the movement of the trucks or the custody of the trucks.
2. Suppliers should know if the material is available in the local markets or not so that they can order a delivery from other markets early and avoid delaying of the material delivery to the contractor.
3. Finally, further researches can be done in this area to increase the awareness of the causes that delay of material delivery and the whole project.

7 CONCLUSION

To minimize the delay of material delivery in the Eastern Province in Saudi Arabia, the critical factors that may cause delay of material delivery have been identified and documented in order to find the most suitable solution for them. This research has spotted the most crucial factors using the experience of different personnel in the construction industry with the use of a simple questionnaire that contained 25 factors. Then using a scientific statistical method, which is RII method (Relative important index), this research was able to quantify the importance of each factor and ranked them accordingly. The highest five factors discovered are sorted from the extremely important to the least important respectively as follows; 1) The late issuance of the purchase order or (Not following the project plan); 2) Late adoption of the material 3) Delay in approving the shop drawings 4) Late issuance of the invoices to the contractor 5) Late issuance of the supplier payment. The experience years of each respondent were taken into consideration in classifying and sorting the vital factors. Moreover, the position of each respondent makes a great influence in the sorting process. After that, the ranking of the factors was according to the importance of the influence of these factors on the delay of material delivery to the construction site. By all of that, this research has achieved its objectives.

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