International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 12 | Dec 2021 www.irjet.net p-ISSN: 2395-0072

Study on the Material Delivery Deviations in Construction Projects in Oman

Karim Fahfouhi[1], Soleen AlHasan[2], Florindo Gaspar[3]

[1]Student, Dept. of Civil Engineering, Polytechnic of Leiria, Portugal
[2]Senior Lecturer, Dept. of Civil & Environmental Engineering, National University of Science and Technology, Oman
[3]Professor, CDRSP, Dept. of Civil Engineering, Polytechnic of Leiria, Portugal

---

Abstract - *Material delivery is a key task in construction projects that is often affected by deviations, influencing the cost and time of the construction. This paper addresses the study of deviations in material delivery at construction sites in Oman. This research examines the causes and how deviations in material affect the cost and performance of construction projects in Oman as well giving some indications on how to mitigate this issue. The research approach was adopted to involve both qualitative and quantitative methods. To fulfil the study's objectives, questionnaire surveys were done, and structured interviews were conducted with experts with different job positions and experience with material delivery in construction projects. In addition, a case study on 13 residential buildings was analyzed and conclusions were drawn about the causes, impacts and recommendations for future implementation to mitigate material delivery deviations in construction projects. The most three dominant reasons that lead to material delivery deviations were found to be poor communication between the supplier and the contractor, poor scheduling of project managers regarding activities and material delivery and poor cost estimation of materials. Increase of work intensity as well as moving on to upcoming activities and put previous ones on hold are measures that mitigate the deviations on material delivery consequences.*

Key Words: **Material Delivery, Material Management, Construction Projects, RII, Oman.**

1.INTRODUCTION

Material management is considered to be a vital system of construction projects in order to accomplish major productivity and profit which can be interpreted by time and cost saving, activity progress and effective material delivery (Mohamad and Anumba, 2006). The main objective of material management is having accessibility to materials any time desired at the right quality and quantity without having any constraints in handling, storing, purchasing and delivery. In construction projects, material delivery is a core task that directly impacts the projects performance in terms of cost and time of tasks completing within budget and time frame.

Patil and Pataskar (2013) and Karoriya and Pandey (2018) emphasize the role of effective material management on construction projects. Poor identification of materials, change of orders and poor delivery may directly induce the total cost of the construction project. Georgekutty and Mathew (2012) display the failure that takes place in each stage of construction, concluding it that contributes to cost, and time overrun by not affiliating effective planning and scheduling into material delivery. The deviations in material delivery, especially in the construction industry, is a worldwide issue, and its impacts are normally a source of time delay, cost overrun and performance decay in construction projects.

Cost of projects remains the essential constraint for project managers. Many deviations occur leading to cost inflation regarding material handling, delivery, quality, and on-site storage. It is very important to implement management systems in order to ensure all activities and materials are adopted according to plan and executed with attention and within order (Tedla and Patel, 2018). In a case study conducted on a project in Sweden, Darvik and Larsson (2010) show that the causes of the delivery deviations can represent 30% of the total cost.

Ahmad et al. (2018) have given out a check list that has been designed to project managers in order to predict deviations that might take place in material management which have a significant impact on time and cost constraints. Stock and Lambert (2001) have pointed out some of the valuable aspects that have to be considered when managing supplies like precision in delivery process, quality of materials and lead-time.

The purpose of this study is to investigate the causes and how material delivery deviations affect performance of the construction projects in Oman and to give indications to have better material management on construction sites regarding material delivery. To achieve the study's aim, a structured methodology of quantitative and qualitative methods was developed to approach this investigated issue.

2. MATERIAL MANAGEMENT AND DELIVERY DEVIATIONS

Efficient project planning requires utter understanding and overviewing of all the activities' objectives and the quality and quantity of the tools and materials needed to perform each particular activity (Rahman et al., 2015). Nyagwara and Datche (2015) have laid out a system on how the project

performance is hindered and affected by 3 types of factors: project related factors, external environment, and project management actions. A construction project is exposed to many related factors such as the type of project, nature of project, complexity of project and the size of the project. In addition, the actions that occur during project management are considered to be very important, which includes communication systems, control mechanisms, feedback capabilities, planning effort, implication of an effective quality assurance, overall managerial actions, and the control of sub-contractors.

There is a vital connection between project management and its performance. Maylor (1988) discusses the various roles in material management and their differences. In material management, a material fragmented structure is important in order to show the material requirements for any construction project, where it is considered to assess each material required in the project, the same way each activity is broken down with information in the activity list of a project. As construction projects are exponentially rising in terms of difficulty and scale, material management must be fully and effectively used. According to Mustapha and Noaum (1998), who have conducted several studies regarding material management in construction projects, there are five categories of factors that have imposing effects on the cost and performance of projects, and they're listed as the following:

- Factors related on to personal and individual characteristics;
- Factors related to work conditions;
- Factors concerning the type and characteristics of a project;
- Factors connected to the environment where the project is taking place;
- Planning and organization factors.

Ofori (2000), based on the interviews made, concluded that the construction industry is disintegrated and lacking proper communication. Ineffective planning often leads to unproductivity, lack of attention, deviations and cost and performance inefficiency, hence, not accomplishing projects' objectives. Materials delivery is often affected by lack of planning. According to Bajpai (2019), materials are often delivered straightly to the construction site, however, in some cases, it is subjected to storage limitations. In these cases, the materials that are supposed to be delivered are sent to the contractors' warehouse or other storage sites. Once these deviations are faced, project managers can end up in materials delivery complications, which lead to delays, effects on cost and performance and not meeting projects' goals.

During construction projects, project managers tend to show low attention to material delivery, which begins with the planning and scheduling phase of any project. Toor and Ogunlana (2008) identified the causes that lead to lack of material delivery, often overlooked by construction managers, which were identified as communication lapses, change of orders, lack of project management practices, poor labor productivity and motivation, different objectives from the clients and lack of professionalism within contractors. Several past studies have identified that these factors are relatively related across different countries and regions.

In addition, deviations that affect material delivery differ depending on the type and size of firms involved in. It is observed that small firms endure the most deviations taking place during material delivery, whereas in medium and big firms, encounter less factors leading to deviations in material management (Ahmad et al., 2018). The following factors affecting material management are the most likely to happen in all size of firms: deny of materials from the material quality check team that leads to delay, transportation issues and seasonal constraints. Medium firms tend to have additional factors such as, labor strikes and inadequate materials handling, whereas small firms face the most factors and other additional factors from all of the above can be defined as communication misunderstanding, rise of materials cost and lack of proper material management. Kulkarni et al. (2017) concluded that general procedures for material management differ for each type and size of construction firm.

Some additional costs may be calculated and measured, on the other hand, some may be invisible to the eye of project managers and may have a bigger impact on the final cost of the project since it is expected or reachable to be minimized (Darvik and Larsson, 2010).

Various factors that affect material delivery and management in general, also influence the performance and cost of construction projects, such as, transportation issues, inappropriate handling of materials, lack of feasible work plan and excess of paperwork (Tedla and Patel, 2018). These factors are considered to be common within developing countries across the construction industry. Also, Chandler and Sayles (1971) have listed five critical factors that directly affect the cost and performance of construction projects, and which can be defined as: lack of efficiency of the project manager, inappropriate activities scheduling, problematic monitoring approach, ineffective project supervision and inconsistent project involvement.

3. METHODOLOGY OF THE STUDY

The methodology that has been used in this study was a combination of quantitative and qualitative methods in order to investigate how the deviations in material delivery influence the cost and performance of construction projects in Oman, and how these deviations are handled on site. Data

was gathered by implementing a questionnaire survey that was answered by 29 professionals and experts in the field. Interviews were also carried out with different engineers in the construction building field and of the material supplying field. For this purpose, a structured interview was set to have taken place with project managers, site engineers and general managers. In addition, a case study was conducted about one residential construction building project in Muscat, the capital of Sultanate of Oman.

The following figure briefs the methodology followed in this paper.

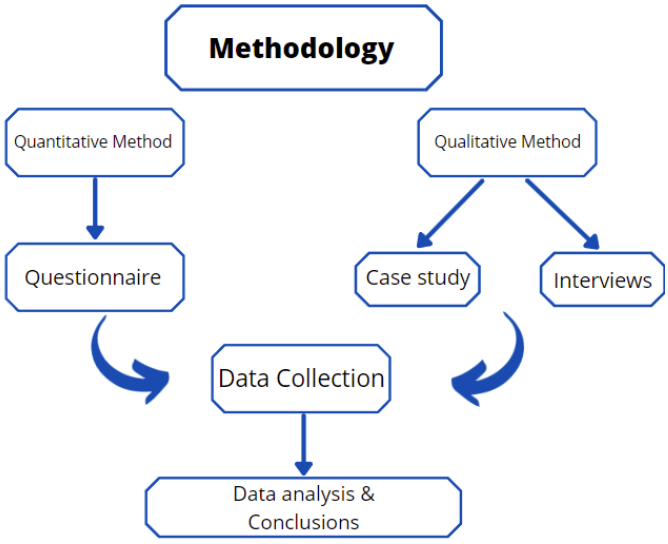

Figure-1: Brief of the methodology adopted

3.1 Questionnaire survey

The aim of developing the quantitative method was to obtain information regarding the relevance and importance of factors contributing to deviations on material delivery in construction projects in Oman.

The questionnaire is composed of two sections. Section 1 aimed to provide general information about the respondents, their academic and professional curriculum. Section 2 aimed to show the frequency of various factors contributing to the material delivery deviations in Oman.

To obtain and study results of these approaches, the Relevance Importance Index (RII) was used, as suggested by Ahmad et al. (2018), in order to analyze the impacts and factors of material delivery deviations. RII gives the mean importance of each factor, showing how relevant it is in the perception of the respondents (Somiah et al., 2015). Many researchers adapt this formula to value the weight of the results collected from the data analysis regarding questionnaire results. To express RII, the following formula is used:

$$RII = \frac{\sum_{i=1}^{5} w_i \, x_i}{A \times N}$$

Where:

RII = Relative importance index

W = weighting given to each factor by respondents, ranging from 1 to 5

X = frequency of i^{th} response given for each cause

A = highest weight (i.e., 5 in this case)

N = total number of participants

The following table shows the RII values corresponding to the importance level for each value.

Table-1: Importance levels of RII ranges 1-5 scale (Sambasivan & Soon, 2007)

RII Values	Importance Level
$0.80 \leq RII \leq 1.0$	High
$0.60 \leq RII \leq 0.80$	High - Medium
$0.40 \leq RII \leq 0.60$	Medium
$0.20 \leq RII \leq 0.40$	Medium - Low
$0.00 \leq RII \leq 0.20$	Low

3.1 Information of the respondents

Information of the respondents was collected about their job positions and experience. Table 2 shows the job positions of the experts involved in answering the questionnaire survey alongside their frequency in the total amount of the respondents. In this study, the respondents with the highest relevant job position are Project Managers with a percentage of 31%, followed by Contract Engineers with a percentage of 27%. There were also Quantity Surveyors and Suppliers involved in this study, which shows that the job positions targeted in completing the questionnaire survey conducted were directly involved with material delivery.

Table-2: Job positions of the respondents

Job position	Respondents	
	Number	Percentage
Project Manager	9	31%
Quantity Surveyor	4	14%
Contract Engineer	8	27%
Suppliers	5	17%
Others	3	11%

Table 3 shows the number of respondents related to the number of years of experience, where it is shown that 79% had more than 5 years of experience. Most of them had 5 to 10 years of experience in the construction engineering field with a percentage of 41% of the total amount, 21% had 10-20 years of experience, and 17% had more than 20 years of experience.

Table-3: Respondents Experience

Years of Experience	Respondents	
	Number	Percentage
< 5 years	6	21%
5-10 years	12	41%
10-20 years	6	21%
> 20 years	5	17%

3.2 Information from the interviewees

The interviews that were included in this case study were from a variety of engineering companies situated in Muscat, Sultanate of Oman. And their corresponding job positions held during the interviews were: Senior Project Manager, Quantity Surveyor, Construction Engineer and General Manager. They belong to different sectors of work such as project management, site engineer and supply chain. The companies where the interviewees were from, were all large, averaging around 10,737 employees across the 4 companies involved. In addition, the engineers' experience in the field was assessed by years of employment which varied from 6 to 22 years of work across the 6 interviewees. The interviewees worked with were listed down in the Table 4 according to their job positions, sector of work, company they work for, academic profile and their experience in the civil engineering field.

Table-4: Information on the interviewees

Q. No	Job positions	Sector of Work	Academic Profile	Experience
1	Senior Project Manager	Project Management	PhD	16 years
2	Senior Project Manager	Project Management	PhD	22 years
3	Quantity Surveyor	Site Engineer	BSc	8 years
4	Construction Engineer	Site Engineer	BSc	6 years
5	General Manager	Supply Chain	MSc	14 years
6	General Manager	Supply Chain	PhD	10 years

3.3 Methodology of Case Study

The case study analyzed and studied in this paper, is about discussing the deviations that occur during delivery stage of many materials ordered by the company, and to find out how these deviations were handled in regards of their impacts and effects. The project under study has taken place in Sultanate of Oman. The project site designated consisted of 13 separate residential buildings, 6 buildings where of 6 floors (ground floor + 5 stories), composed with 12 flats, and the other 7 buildings were of 7 floors (ground floor + 6 stories), having 14 flats. The project's start date was on November the 15th of 2017.

4. RESULTS AND DISCUSSIONS

4.1 Questionnaire Results

4.1.1 Factors contributing to material delivery

The respondents involved in answering the questionnaire survey were tasked to indicate the frequency of each factor based on their experience and knowledge. From a scale of 1 to 5, where 1 means the factor is not frequent and 5 means the factor is most frequent.

From the figure 2, it can be concluded that the deviations most dominant from the study conducted are those related to suppliers according to their RII value which is 0.71. And the deviations related to project managers are the second dominant with a RII value of 0.66. The deviations least significant are the ones related to contract engineers with a RII value of 0.65. From these findings, suppliers pose the most threats to deviations in material delivery, and this could be probably due to the fact that supplying companies also depend on the availability of the materials from the manufacturing companies, being more relevant than contract engineers and project managers. Also, these results can depend on many aspects regarding material delivery linked to the supplying companies. Here are some:

- Communication regarding types of materials to be produced.
- Quantity and quality of materials to be produced.
- Price negotiations with the client.
- Material design discussions.
- Production of materials.
- Handling of materials.
- Date of delivery discussions.
- Delivery of materials.

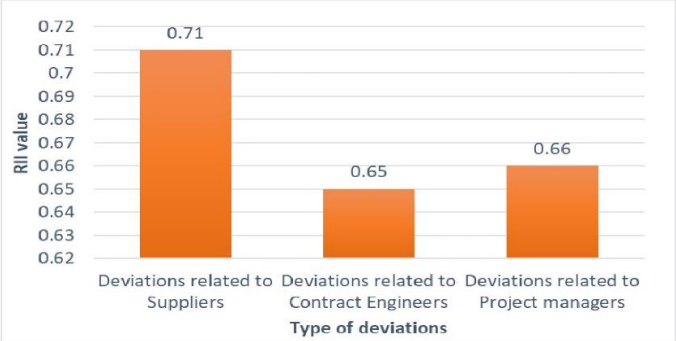

Figure-2: RII values according to the types of deviations

4.1.2 Deviations related to suppliers

There has been found from the literature review, that under the deviations related to suppliers, 9 types of deviations can usually take place. These 9 deviations have been identified to be: delay in approval, poor communication, poor delivery, transportation issues, poor quality of materials, misunderstanding, improper material production, over production of materials ordered and delay in site delivery. Respondents have been asked to indicate their relevance of occurrence based on their experience and knowledge, and these deviations in material delivery related to suppliers are shown in Table 5 and ranked based on their relevance and their occurrence in construction projects in Oman.

Table-5: RII values of causes of deviations related to suppliers

Q. No	Factors	RII	Rank
1	Delay in approval	0.77	3
2	Poor communication	0.92	1
3	Poor delivery	0.81	2
4	Transportation issues	0.77	3
5	Poor quality of materials	0.68	5
6	Misunderstanding	0.69	4
7	Improper material production	0.63	6
8	Over production of materials ordered	0.55	8
9	Delay in site delivery	0.57	7

The most dominant factor was found to be "Poor communication" with a RII value of 0.92, which is also according to the results of Toor and Ogunlana (2008). The second important factor was found to be "Poor delivery" with a RII value of 0.81, which is probably related with many regulations and stress on the material delivery process. The deviation found with the least RII value (0.55) indicates the "Over production of materials ordered" was the least relevant in construction projects in Oman. This is probably linked with commercial needs of the supplying companies which tend to watch their materials production numbers according to the client's desires.

4.1.3 Deviations related to contract engineers

The deviations in material delivery related to contract engineers are listed down in the Table 6 according to their frequency of occurrence in construction projects in Sultanate of Oman. It was found that "Poor cost estimation" and "Delay in payments", with a RII value of 0.78, were the two most frequent factors leading to material delivery issues in construction sites. Possible reasons for the poor cost estimation can be linked with the clients' financial desires and/or poor communication between the client and contract engineer. And the delay in payments has a strong relation with poor cost estimation. "Change of orders" was found to be second with a value of 0.73, "Financial issues" was found to be the third relevant factor holding a value of 0.71, the fourth frequent factor was studied to be "Delay of in decision making" marking a value of 0.52, and the two least frequent factors were found to be "Unspecific orders" and "Insufficient data collection" with values of 0.51 and 0.50 respectively.

Table-6: Causes of deviations related to contract engineers

Q. No	Factors	RII	Rank
1	Unspecific orders	0.51	5
2	Financial issues	0.71	3
3	Delay in decision making	0.52	4
4	Change of orders	0.73	2
5	Poor cost estimation	0.78	1
6	Insufficient data collection	0.50	6
7	Delay in payments	0.78	1

4.1.4. Deviations related to project managers

In the Table 7 the list of the eight deviations related to project managers is provided according to the questionnaire survey conducted in Oman. From the values of RII calculated in this study, it can be seen that "Poor scheduling" is the most frequent factor with a RII value of 0.88, and the second relevant factor is "Poor planning" with a RII value of 0.86. These causes were also the most relevant appointed by Ayegba (2013), followed by "Lack of coordination" with a RII value of 0.72, "Improper material handling" comes after with a value of 0.63 in the fourth place, followed by "Material damage on site" with a RII value of 0.61, then "Inadequate Project objectives" holding a RII value of 0.55 and the two least frequent cause were found to be "Excessive paperwork" and "Lack of experience of project managers" with RII values of 0.54 and 0.43 respectively.

Table-7: Causes of deviations related to project managers

Factor	RII	Rank
Inadequate Project Objectives	0.55	6
Lack of coordination	0.72	3
Excessive paperwork	0.54	7
Poor planning	0.86	2
Improper material handling	0.63	4
Poor scheduling	0.88	1
Material damage on site	0.61	5
Lack of experience of project managers	0.43	8

4.1.5. Deviations in material delivery in construction projects

From the Table 8 it can be concluded by the fact that the two most dominant factor contributing to Material Delivery Deviations in construction projects in Oman are "Poor Communication" and "Poor Scheduling" with RII values of 0.92 and 0.88 respectively, and these factors tend to come from Project managers and Suppliers since communication and scheduling take place before any production of the materials ordered. The third and fourth factors with the most frequency and relevance are "Poor Planning" and "Poor Delivery" with RII values of 0.86 and 0.81 respectively, which makes sense since these factors are as related as the past two factors in Material Delivery in construction projects across all developing countries.

It can be concluded that the least common set of factors contributing to deviations in material delivery in construction projects in Oman are "Excessive Paperwork", "Delay in Decision Making", "Unspecific Orders", "Lack of Experience of Project managers" and "Insufficient Data Collection" with RII values of 0.54, 0.52, 0.51, 0.50 and 0.43 respectively.

Table-8: Factors contributing to deviations on material delivery in construction projects

Deviations in Material Delivery	RII Value	Rank
Delay in Approval	0.77	6
Poor Communication	0.92	1
Poor Delivery	0.81	4
Transportation Issues	0.77	6
Poor Quality of Materials	0.68	11
Misunderstanding	0.69	10
Improper Material Production	0.63	12
Over Production of Materials Ordered	0.55	15
Unspecific Orders	0.51	18
Financial Issues	0.71	9
Delay in Decision Making	0.52	17
Change of Orders	0.73	7
Poor Cost Estimation	0.78	5
Insufficient Data Collection	0.50	19
Inadequate Project Objectives	0.55	15
Lack of coordination	0.72	8
Excessive Paperwork	0.54	16
Poor Planning	0.86	3
Improper Material Handling	0.63	12
Poor Scheduling	0.88	2
Material Damage on Site	0.61	13
Delay in Payments	0.78	5
Lack of Experience of Project Managers	0.43	20
Delay in Site Delivery	0.57	14

4.2 Interviews outcomes

4.2.1 Project managers' interviews

From the two interviews conducted it was obtained that from a project manager's perception deviations in material delivery are very common across most of construction projects in Oman. And each project manager decides with the help of other engineers the procedure to be undertaken in order to deal with the occurrence of such nuance on construction sites. From the senior project managers' perspectives, it is crucial that project managers ensure that the cost and performance remain intact in regards of the projects' objectives and client's satisfaction. However, according to the interviews, it is very rare when projects in Oman don't encounter such issues, and eventually the cost and performance are affected. Project managers tend to increase the work intensity and add up more shifts to the momentum of the project in order to avoid any delay in activities of the project.

4.2.2. Site engineers' interviews

According to the site engineer's answers to the interview questions, some project managers usually apply enough pressure on the supplying company in order to enhance the delivery time consistency of the supplier, ensure that there is no communication gap between project's managers and suppliers in order to avoid any further deviations in material delivery. In addition, it is advised to have a constant follow up from the project managers to the supplying company, submitting the necessary documentation of late material delivery.

The results obtained from the two interviews conducted with the two site engineers in this study were found to be matching. The two engineers with significant experience in the engineering field in construction projects in Oman, tend to have two solutions to the occurrence of deviations in material delivery on construction site. First one is to involve and strengthen their workforce in order to compromise the delay in activities caused by the deviations in material delivery. And second, in order to avoid project's delay, site engineers decide to move on to upcoming activities and put

previous ones on hold in order to not obtain any delay and not to put all the activities on hold due late delivery.

4.2.3. Suppliers' interviews

Supply chain managers in supplying companies in Oman tend to have specific ways to deal with deviations of material delivery occurring in construction projects, due to late delivery, misunderstanding or poor communication between project managers and suppliers.

From the interviews conducted with the responsible general managers in supply chain in this study, it was found that engineers in supplying companies had the responsibility to deal with communication and negotiations with clients regarding delivery of materials, production of materials and change of orders from project managers. Due to many deviations that take place in the process of material delivery, and according to the information provided from the interviews, other ways of dealing with these deviations are: constant follow up with client in order to understand the objectives of the transactions and negotiations for material production and delivery, ensure no room for misunderstanding by setting up intensive set of meetings with clients and all the negotiations to be in written format in order to be recorded and to avoid misunderstanding.

From the interviews conducted with various experts in the civil engineering field with various job positions in the construction industry in Oman, it was concluded that the impacts from the deviations in material delivery were handled in such a way to mitigate the undesired and consequences, such as delay of the project, increase of the project cost, unpleased clients, and unachieved project objectives.

4.3 Case study Analysis

The issue in this project regarding material management was the deviations that took place during material delivery process. The Project Manager takes full responsibility of every aspect and activity that was undertaken during the construction of this residential building. The quantity surveyor has the ability to design, perform site investigation in multiple occasions, studies the content of the scope of work of each activity and makes the work breakdown structure, according to the site management planning and scheduling of activities. The project manager, in this project, as per agreement, has full control of material ordering, delivering, and handling on the construction site. There was a late delivery of some specific materials (marble tiles, kitchen appliances, sliding doors), as per contract, and it was agreed to be delivered at a reported quantity, which in this case, unfortunately wasn't. This late delivery issue has had some significant deviations on project cost, material delivery, material management and the time or duration of the project, therefore on the performance of the construction project. The Quantity Survey (QS) office has come up with a reliable solution, which was to increase the man work and double up the number of shifts since some activities have been put on pause since the amount and quantity of marble tiles was insufficient on the site. And this increase of man-work alongside the impacts of the deviations, have led to an increase to the project cost since some activities were on hold. The project has been delayed with a duration of 8 months, due to other deviations as well. In conclusion, the project faced many undesired consequences due to poor communication between the project manager and the supplying companies responsible. Therefore, in this case, misunderstanding led to a number of impacts and many ways to compromise the delay and dip in performance of the project, the project manager had to agree on the many solutions provided by the QS office. Furthermore, to summarize the main points to be considered in this case study are as follow:

- Poor communication was a factor that led to late delivery of materials;
- The supplying company was responsible by deviations in material delivery;
- There was misunderstanding between the project manager and the supplying company;
- The poor communication led to delaying of some activities that were put on hold, and it was estimated that have caused the project delay by 2 months;
- Cost of the project had to suffer additional increase due to rise of man-work and shifts.

5. CONCLUSIONS

A questionnaire survey was developed in order to be distributed to 29 engineers with various job positions across Muscat, Sultanate of Oman. The respondents indicated the frequency/relevance of occurrence different factors contributing to deviations in material delivery previously identified from the literature review. A set of interviews were conducted with six engineers with different job positions across the country, namely, project managers, site engineers and suppliers. In addition, a case study was adopted in this study, in order to find out about the technical relevance of the deviations in material delivery, which was about a construction project in Muscat, Sultanate of Oman.

The results gathered from the answers of the targeted engineers in the questionnaire set in this paper had shown that the set of the most relevant causes of deviations in material delivery were found to be poor communication, poor scheduling, poor planning, poor delivery, and delay in payments with RII values of 0.92, 0.88, 0.86, 0.81 and 0.78, respectively.

From the interviews conducted in this paper, the common deviations in material delivery were grouped into 3 types: deviations related to suppliers, deviations related to contract engineers and deviations related to project managers. Where regarding to suppliers, it was found that the most important factor was found to be poor communication, and for contract engineers, it was concluded that poor cost estimation and delay in payments were the two most frequent factors leading to material delivery issues in construction sites and lastly, the most relevant deviation related to project management in material delivery was found to be poor scheduling.

According to the interviews and case study results, communication is confirmed as being a key factor on the material management. On the other hand, the increase the work intensity as well as moving on to upcoming activities and put previous ones on hold are measures that mitigate the deviations on material delivery consequences.

ACKNOWLEDGEMENT

This work is supported by the Fundação para a Ciência e a Tecnologia (FCT) and Centro2020 through the following Projects: UIDB/04044/2020, UIDP/04044/2020, UIDB/00308/2020 and PAMI - ROTEIRO/0328/2013 (Nº 022158)

REFERENCES

[1] Ala-Risku, T. and Karkkainen, M. (2006), "Material delivery problems in construction projects: A possible solution", International Journal of Production Economics, Vol.104 No.1, pp. 19-29.

[2] Ayegba, C. (2013), "An Assessment of Material Management on Building Construction Sites", Civil and Environment Research, Vol. 3 No. 5, pp.18-22.

[3] Bajpai, P. (2019), "Biobased Polymers: Properties and Applications in Packaging", Elsevier, Amsterdam.

[4] Chandler, M.L. and Sayles, L. (1971), "Managing Large Systems", The Free Press, New York, NY.

[5] Darvik, L and Larsson, J., (2010), "The impact of material delivery deviations on costs and performance in construction projects", Master's Thesis submitted in partial fulfilment of the requirements of Chalmers University of Technology, Sweden.

[6] Georgekutty, C.K. and Mathew, G. (2012), "Research methodology for material optimization in construction project", International Journal of Engineering and Innovation Technology, Vol. 1 No. 6.

[7] Karoriya, D. and Pandey, M. (2018), "Efficient Techniques of Construction Material Management in Construction Projects: A Review", International Research Journal of Engineering and Technology, Vol. 5 No. 3, pp.1136-1138.

[8] Kulkarni, V., Sharma, R. and Hote, M. (2017), "Factors Affecting Material Management on Construction Site", International Research Journal of Engineering and Technology, Vol. 4 No. 1, pp.474-478.

[9] Maylor, H. (1988), Project Management. Third edition. India: Dorling Kindersley.

[10] Mohamad, S.F. and Anumba, C.J. (2006), "Potential for improving site management practices through knowledge management", Construction Innovation, Vol. 6 No. 4, pp. 232-249. https://doi.org/10.1108/14714170610713917

[11] Mustapha, F. and Naoum, S., (1998), "Factors influencing the effectiveness of construction site managers", International Journal of Project Management, Vol. 16 No. 1, pp.1-8.

[12] Nyangwara, P. and Datche, E. (2015), "Factors Affecting the Performance of Construction Projects: A survey of Construction Projects in the Coastal Region of Kenya", International Journal of Scientific and Research Publications, Vol. 5 No. 10, pp.1-14.

[13] Ofori, G., (2000), "Challenges of Construction Industries in Developing Countries: Lessons from Various Countries", 2nd International Conference on Construction in Developing Countries: Challenges Facing the Construction Industry in Developing Countries, 15-17 November 2000, Gabarone.

[14] Patel, H., Pitroda, J. and Bhavsar, J. (2015), "Analysis of factors affecting material management and inventory management: survey of construction firms using RII method", In International Conference on: "Engineering: Issues, opportunities and Challenges for Development", Bardoli, 11th April 2015.

[15] Patil, A.R. and Pataskar, S.V. (2013), "Analyzing Material Management Techniques on Construction Project", International Journal of Engineering and Innovative Technology, Vol. 3 No. 4.

[16] Rahman, A., Memom, H. and Karim, A. (2013), "Relationship between factors of construction resources affecting project cost", Modern Applied Science, Vol. 7 No. 1, pp. 67-75.

[17] Somiah, M., Osei-Poku, G., Aidoo, I. (2015), Relative Importance Analysis of Factors Influencing Unauthorized Siting of Residential Buildings in the Sekondi-Takoradi Metropolis of Ghana. Journal of Building Construction and Planning Research, Vol. 3, pp.117-126.

[18] Stock, J. and Lambert, D., (2001), "Strategic Logistics Management. The McGraw-Hill/Irwin Series in Marketing", 4th Edition. England: McGraw-Hill/Irwin.

[19] Toor, S. and Ogunlana, S. (2008), "Problems causing delays in major construction projects in Thailand", Construction Management and Economics, Vol. 26 No. 4, pp. 395-408.