An Investigation Of Problematic Issues Associated With Construction Material Management In Libyan Construction Projects – Tripoli as case study

Mohammed Alzohbi[a], Mohammed Abodina[b] , Abdul Gadir Alzoghbi[c]
[a,b]Department of Civil Engineering, Jado Engineering Faculty- Jado / Nalut University - Libya
[c]Department of Civil Engineering, Engineering Faculty/ Sirte University - Libya

*M. Alzohbi: m.alzohpi75@gmail.com

Abstract:

Construction industry is largest economic expenditure and the second largest economic activity after oil industry in Libya. According to expertise's' expectation, the rapid growth of the Libyan's construction sector, particular in the reconstruction phase, is expected to attract investments worth about 16 billion U.S. dollars over the next ten years (2012 – 2022). This growth is going to increase the consumption of building materials within large-scale projects that will be undertaken. Researches have shown that construction materials and equipment may constitute more than 70% of the total cost for a typical construction project. Therefore, the proper management of building materials can improve the productivity and cost efficiency of a project and help ensure its timely completion. Hence, there is a pressing need for investigating the problematic issues that impede the optimal application of Construction Materials Management (CMM) in the Libyan construction projects.

This study thus aims to identify the problems facing the process of materials management in Libyan construction projects, and then evaluate the CMM problems in terms of the severity of their impact (their importance) and frequency of occurrence in those construction projects implemented in the municipality of Tripoli, which has the largest density in construction projects, and during the time period between 2000 to 2011, which is considered the boom period in the Libyan construction industry.

The study adopts a mixed research methodological approach involving in depth literature review process and quantitative approach using questionnaire technique. For the analysis of the data collected by 35 questionnaires, the latest "statistical software packages (SPSS22)" was used, which raises the degree of reliability and validity of the results and therefore the entire study.

The main findings of the study are to identify 36 problems facing the process of the CMM and classify them according to the functions included the CMM process. This was followed by an assessment of those CMM problems in terms of their importance and frequency of occurrence in Libyan construction projects in Tripoli.

Keywords: Libyan Construction Industry (L.C.I); Construction Materials Management (CMM); CMM Problems; CMM Problems Evaluation; Case Study – Tripoli.

Introduction:

The construction industry is a project-oriented industry that converts a variety of resources into constructed social and economic infrastructure and facilities [1] [2]. The uniqueness natural of building project implies that each construction project is characterised by its temporary nature particularly with respect to the fragmentation and the geographical dispersion of the production site [3] [4] [5]. This makes construction projects complex in that they involve many organisations and participants, such as owners/clients (employers, accountants and financers), architects (designers, planners and supervisors), contractors (executive managers, engineers, professionals and construction workers), insurers, materials suppliers and vendors [6] [7].

Typically, in the construction projects, the cost of materials and equipment used represents around 60-70 % of the total cost of these projects, and an effective materials management system could reduce bulk materials surplus from a range of 5-10% of bulk materials purchased to about 1-3%, and reduce about 30% of man hours needed for materials management [8] [9] [10].

However, the uniqueness of the construction projects makes the management of materials a challenge that has continued to cause a major obstacle to the success and profitability of these projects. As projects grow in size and complexity, Construction Materials Management (CMM) particularly in large projects becomes more complex and difficult and the need for outstanding CMM techniques becomes essential. Consequently, monitoring the CMM process and investigating the problematic issues that can face its functions is unavoidable to identify the obstacles that impeding the optimum CMM, and the developing the improvements that is needed.

Accordingly, this research seeks to explore and classify the problems facing the process of CMM, and to evaluate these problems in terms of their importance and frequency of occurrence in the Libyan construction projects in the case study of Tripoli, where the largest density in construction projects, and during the

time period between 2000 to 2011, which is considered the boom period in the Libyan construction industry [11].

Materials management in construction (CMM):

Definition of Materials Management:

Various definitions for materials management can be found; however, the majority of the authors of contemporary literature such as, [12], [13], [14], and [15] preferred the definition that was provided by the Business Roundtable [16], which is considered as the most common of which. Materials management is defined as; "*planning and controlling all the necessary efforts to ensure that the correct quality and quantity of materials and installed equipment are appropriately specified in a timely manner, are obtained at a reasonable cost, and are available when needed*" [17, p14].

Nevertheless, they all agree with [17], [18] and [19] that materials management is a process rather than an organisation, which encompasses activities that go beyond the organisational boundaries to embrace the outside organisations such as those of vendors and subcontractors. Concerning the construction context, Muehlhausen [20] defined construction materials management (CMM) as;

"the process of planning, executing, and controlling of all activities influencing the flow of materials to and through the jobsite. These activities include the design of the structure, materials requirements and project planning, requisitioning of materials, purchasing materials, expediting shop drawing approval and materials fabrication and delivery, shipping the materials, receiving the materials at site or other storage location, and sorting and handling the materials" [12, p4].

In short, one can note CMM is a process for planning to secure the availability of the construction materials whenever and wherever they are needed and to ensure that the right quality and quantity of materials are appropriately selected, purchased, delivered, and handled onsite in a timely manner and at a reasonable cost [15]. These functions and activities that compose the CMM process should be interrelated [19].

The importance of CMM process:

From the definitions mentioned above, it can confidently say that managing materials successfully can play a key role in the construction project success. Moreover, the importance of materials management in construction projects can be demonstrated from various perspectives in the majority of the literature related to materials management, among many others, those are shown in **Table 1**.

Table 1: The importance of materials management in construction

The author	The importance
[21]	"Effective materials management will result in 6 to 8% improvement in labour productivity, improved cash flow, reduced bulk materials surplus, reduced materials management human resources, improved vendor performance, reduced requirement for physical warehouse facilities, quantity purchasing discounts, minimized cost impact of change orders and fewer project delays"
[18]	"The lack of materials is one of the most common causes of delays in construction"
[12]	".....the need to implement an Effective Material Management System in construction is highly desirable".
[22, p39]	"A well-managed materials management system can contribute to the cost effectiveness of a project"
[23, p39]	"Materials management is an important element in project planning and control".
[24]	Materials management is an important function for improving productivity in construction projects.
[25]	Lack of materials management in construction projects represents the most frequent problem in managing the construction site and the third most important problem of the construction sites, in terms of their effect on managing the construction site, after problems of planning and design.

The statements above further illustrate that improper management and handling of materials during the construction process can dramatically influence the total project time, cost, and quality. Given the impact on cost, schedule, and quality, it can be concluded that CMM in complex and large construction projects needs adequate consideration, the effectiveness of its performance needs to be measured, and the problems that may be encountered by the

CMM process must be identified and their effects must be evaluated.

Roles of the CMM parties and responsibilities:

Edum-Fotwe, *et al.* [26] and Hatmoko [27] argue that the parties involved in the CMM process may vary according to the stage of the construction. However, among many constructions related authors, Muya [28] and Perdomo [22] believe that the key parties within CMM process include clients, main contractors, subcontractors, materials suppliers, and/or vendors. All these provide input of one form or another which goes towards the realisation of projects.

Based on the fact that among the essentials for getting people to function well in such an organizational arrangement is that "people want recognition for their work [9]. Many of the construction companies, thus, manage materials in the large projects through an informal team, using responsibilities matrices such as the one in **Figure 1**. The role and responsibilities matrix, which are usually represented within the materials management organization, represent the responsibilities of several people from different departments [22]. However, the coordination of activities operating within the context of matrix of responsibilities require considerable skill and experiences.

	Materials Management Plan	Reorder Status	Requisition control/processing	Expediting/traffic	inspection	Shop fabrication control	Inventory control	Field requisition	Field buying	Change order evaluation	Surplus disposition
PROJECT MANAGEMENT	A		A	A	A					A	A
ENGINEERING					I E						
PROJECT CONTROLS										E	
MATERIALS GROUP										E	E
MATERIALS COORDINATOR	I E C	I E C	I E C	C	C	I E C	C	C	C	I C	I C
CONSTRUCTION				E	E		I E	I E	I E	E	E

I: INITIATE A: APPROVE E: EXECUTE/PREPAR C: COORDINATE

Figure 3.1: The responsibility matrix for CMM process ([19], p74)

Those key parties play important roles in the success of the CMM process as they occupy strategic positions in the process. However, their roles and responsibilities should be identified from the earlier time of project planning or may be before signing a contract. Each construction company has its particular materials management system where the responsibilities for various functions and activities are spread between engineering, purchasing, and construction [23][29].

Construction material management process:

It can be concluded from the research studies presented earlier that the management of construction materials is a process that includes various activities which exceed the organizational boundaries of a construction project. This supports the perspective of Construction Industry Institution (CII) [8]; it stipulates that "*Project materials management should be thought of as a process rather than an organisation*". [19] [9] justified the necessity for this vision and they believe that recognizing CMM as a process rather than a function or organisation is very important, because processes imply a common set of goals, as distinct from just some commonality in activities, and the use of this vision (a system or process) to CMM provides a means of looking at assumptions that govern existing techniques and enable one to think in terms of innovations that affect the entire system.

In construction projects, the number of materials is very large and that there is a wide variety of suppliers, which makes the process of supplying materials to the building sites difficult to manage, even for a moderate construction project. Therefore, the material supply process in building projects involves many functions and activities, carried out on several different departments. The integration of these functions is the only successful means to ensure that materials are considered in project planning, controlling and directing activities. [8] [17] [14].

In recent years, the contractors involved in construction projects have developed integrated (Total Concept) material management

systems that combine and integrate a number of functions and activities [9]. Nevertheless, due to the differences in the type, size, and location of the construction projects, some differences in the functions and activities that form the integrated system of CMM can be pinpointed. Therefore, in order to understand and define the integrated functions involved in the CMM process, it was vital to conduct a survey of the literature related to material management in the construction projects. The detailed examination of the related literature reveals different forms of the CMM process that involves various integrated functions, as summarised in **Table 2**.

Although there are relative differences between the functions that form the CMM process and their order (as illustrated in Table 2 above), there are essential commonalities that can be discerned. It can be derived from **Table 2** that the most common integrated functions that are used by various construction contractors and that can be considered as commonalities among the CMM processes are; 1) Project planning, 2) Material take-off, 3) Vendor enquiry and evaluation, 4) Purchasing, 5) Expediting and transportation, 6) Field control, 7) Warehousing, 8) Material Issues, 9) Surplus Materials, and 10) Quality management (Quality Assurance and Quality Control).

Table 2: Summary of the Theoretical Studies on the Process of Construction Material Management

Author(s)	The Integrated Functions Form the CMM Process	Author(s)	The Integrated Functions Form the CMM Process
[30]	Project Planning Material Take-off Vendor Inquiry and Evaluation Purchasing Expediting and Transportation Field Material Control Warehousing	[33]	Materials takeoff Purchasing concerns Establishment of forms and procedures Developing standards terms Issuing request for quotations; Evaluating bids; Quality management Expediting Shipping Warehousing
[8]	Material Specifications and Take off Vendor Selection Order Approval and Quality management Expediting and Transportation Fabrication and Delivery Installation	[34]	Planning Materials Take-off Vendor Enquiry Purchasing Material Control Warehousing Expediting and Shipping
[31]	Material Requirements Planning and Control Purchasing Expediting Quality Assurance and Quality Control Transportation Site Materials Management Surplus Materials	[23]	Procurement and purchasing Expediting .Materials planning .Materials handling Distribution Cost control Inventory management / Receiving/ Warehousing Transportation
[17]	Planning Material Take off and Design Interface Vendor Inquiry and Evaluation Purchasing Quality management Expediting and Transportation Warehousing Field Control Issue of materials	[15]	Planning Materials Take-off Vendor Enquiry Purchasing Material Control Warehousing Expediting and Shipping

Author(s)	The Integrated Functions Form the CMM Process	Author(s)	The Integrated Functions Form the CMM Process
[9]	Planning and Communication Materials Requirements and Engineering Interface Vendor Inquiry and Evaluation Purchasing Quality Assurance and Control Warehousing, Receiving, and distribution Field Material Control	[24]	Planning Procurement Logistics Handling Stock and Waste Control
[12]	Materials take off and Vendor Selection Purchasing Quality management Expediting Shipping Receiving Warehousing Issues of materials	[35]	Materials take off, Purchasing, Expediting, Receiving, Warehousing and Distribution
[28]	Purchasing policy Construction phase The buying schedule The materials schedule Site logistics activities Expediting Deliveries and receiving of materials Quality control Materials handling on site Inventory management Issue of materials	[36]	Materials Requirements Planning (MRP) Purchasing Inventory Planning and Control Ascertaining and Maintaining the Flow and Supply of Materials · Quality Control of Materials · Departmental Efficiency
[32]	Requirements Planning Purchasing Warehousing Co-operate with production/operations Shipping Receiving Information maintenance	[37]	planning, Identification, Procuring, Storage, Receiving, and Distribution of materials.

However, in the Arabic Construction Industry, Alzohbi [19], found that some activities of these ten functions are integrated. Based on the boundaries of the CMM process that were identified

by Alzohbi [19], the main functions that can form the typical process of CMM within the Jordanian Construction Projects are combined into six integrated functions; **1)** Planning as the first function and then followed by **2)** Material Take-off and Design Interface, **3)** Material Procurement and Transportation, **4)** Quality Management, **5)** Warehousing, and **6)** Field Control.

In order to comprehend and communicate the process inputs, attributes, functions, activities and outputs, one of the most common techniques used is the process workflow diagram. Alzohbi [19] developed a workflows diagram to represent the typical materials management process for a typical construction project in Arabic Construction Industry (Jordan as case study) as shown in **Figure 2**. The figure below illustrates the overall workflow diagram of the CMM process which is considered in this research as the basic framework for communicating the integrated typical functions and activities that shape the materials management process in the construction industry. From the figure, one can note that project planning is nominated as the first function in the CMM diagram and that it has received the primary process input in the form of material related information from the project team. The end process boundary is defined by the primary process output that is linked to issuing materials to the primary customer who is involved in construction operations and who represents those craft-workers to whom the materials are issued. The typical CMM Process workflow diagram(s) represents the first step in classifying the problems of the CMM process, as will be discussed below.

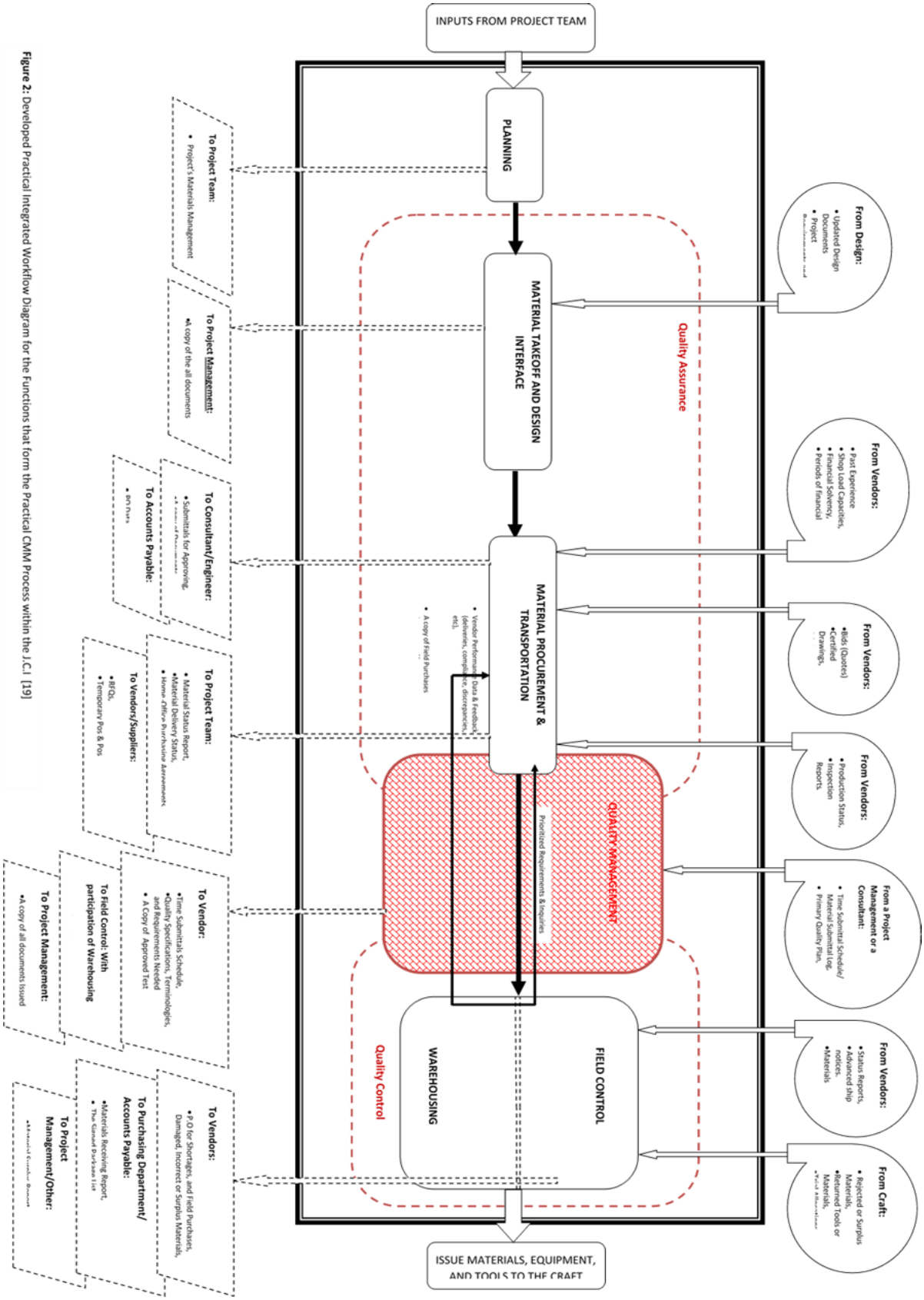

Figure 2: Developed Practical Integrated Workflow Diagram for the Functions that form the Practical CMM Process within the J.C.I [19]

Problems of the CMM process:

Owing to the complex and dynamic nature of the construction industry, CMM process faces many unique challenges start with material planning, ordering, receiving and storing, handling and distribution, site usage and monitoring. Poor materials management has been identified as a major source of low construction productivity, cost overrun and delays.

Identification of the CMM Problems:

Due to a lack in studies directly related to problems that CMM into the Libyan or even the Arabic construction projects, an in-depth investigation has been conducted concerning problematic issues which contribute to poor materials management in various construction industries worldwide. **Table 3** summarises the outcomes of the literature on problematic issues of construction material management that exposes different problems and challenges that face the CMM Process.

Table 3: Summary of the Theoretical Studies on the Problems of the CMM Process

Author(s)	The problems of the CMM Process
[38]	Waste, Transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork.
[18]	Problems related to design; delays, incompleteness, lack of details and inconsistencies between different designs. Lack of planning and organization of transportation and delivery. Incomplete or inconsistent materials specification. Lack of estimation of the amount of materials needed. Delays in price surveys (or suppliers bidding) and in ordering materials; Delays in checking stocks.
[39]	Receiving materials before they are required; Not receiving materials at the time. of requirement; Incorrect materials take-off from drawings and design documents; Subsequent design changes; Damage/loss of items; Improper Selection of type of contract for specific materials procurement; weakness of Vendor evaluation criteria; Piling up of inventory; and

Author(s)	The problems of the CMM Process
	Poor Management of surplus materials.
[40]	Lack of site storage space Problems with tower crane distribution Problems on logistic of materials Problem with one site access point Difficulty in delivery of materials on site during aircraft operation Operation limitation due to security considerations Inefficient in the recording information of materials within a supply chain Problems with congestion time at loading area
[24]	conflict among sub-contractors and difficulty to coordinate their materials, late delivery of ordered materials, cash flow problem to contractor due to delayed payments, rejection of materials due to non-compliance to specification and improper health and safety procedure should injuries occurred.
Goodrum and Maloney (2009)	Late transportation of materials and equipment on site; Poor materials management among sub-contractors; Poor plan for 'Materials on-site transportation'
[41]	Improper deposited material, Improper material handling, Improper material application and Improper material deliveries and Shortage of materials
[10]	Materials Identification Problems: Undefined scope Lack of communication between parties involved Incomplete drawings due to uncompleted plans and missed details, Lack of conformance to requirements, Nonstandard specifications, Difference between plans and specifications. Vendor Selection Problems: Uncontrollable bid list: Have too many suppliers and too little information, Incomplete proposals: Suppliers do not include all documents required, Time spent in investigating nonqualified suppliers. Procurement Problem: Availability of material type/quantity, Price reduction to match competitor's price, Late deliveries: Materials are not delivered as per schedule Late or incorrect submittals, Unrealistic delivery dates, Vague stated requirements Lack of communication Re handling of materials, Storage areas are limited or are far from working area, Theft, Damage during handling or other conditions. Construction Phase Problems: Incorrect type of material delivered: There are differences in material ordered and delivered, Incorrect sizes delivered, Incorrect quantities delivered,

Author(s)	The problems of the CMM Process
	Keeping track of material: Don't know where materials are at a certain period of time, Re handling of material, improper Storage conditions, Loss/Damage of material, No supplier QA: No quality assurance from supplier, Poor communication, Receiving, handling and storage of unused materials.
[42]	Organisation Structure: No good definition of what is wanted Lack of communication, Specification are not commonly used, Don't communicate exactly what is wanted to suppliers, Incomplete drawings Unclear specifications. Procurement Problems: Available of material, Available of quantities, Unscheduled delivers, Late/incorrect submittals, Poor inter-communication, Lack of conformance to requirements, Delivery dates impossible to meet, Materials to be moved from one place to another, Material Damage. Storage Scope: Large number of materials and limited of storage space, Poor protection against many threats (theft, damage or loss), The size of storage building comparing to the size of the project size. Availability of Materials on Market: Steady flow of materials throughout project duration is among the primary CMM functions, Occasionally manufactures can run of raw material or be affected by government policy to the extent that production may have to be slow or suspended.
[37]	overstocked materials because of improper planning, stealing and loss of materials because of improper supervision, waiting of the materials to arrive in location due to improper tracking systems, frequent moving of materials due to improper site layout, the shortages and changes of construction materials quantity required, delay in updating/posting storage system on site, inaccurate estimation of shipment quantity of materials, uneconomic order quantity of materials, poor shipping time, increasing transportation or storage cost of materials, poor policy in purchasing the materials.

From the **Table 3** above, it can be seen that the problems of the CMM process vary in nature and intensity but are usually related to the inefficient management of construction resources,

incomprehensive plan, poor procurement methods, bad coordination between subcontractors, and improper site layout.

A set of **36** problems was identified to represent the most problematic issues that contribute to poor materials management in building construction projects as a result of the list of problems that are identified in the literature related to different construction industries; this included removing duplicates and items not related to the defined CMM functions, re-formulating and modifying some problematic issues to fit the building construction sector (See **Table 4**).

Classification of the CMM Problems:

[40] believes that due to the fact that the problems in materials management will be never ending, it is plausible that identification and classification of the CMM process's problems may be the fundamental step to overcome the challenge of materials management in the construction industry. There are many criteria of which the dilemmas faced in materials management can be classified based on; their effect, causes, who on charge or the function related to. In this study the identified CMM problems are sorted on the basis of the functions that are related to; Planning, Material Take off & Design Interface, Material Procurement & Transportation, Quality Management, Warehousing and Field Control, as listed in **Table 4**, which includes the problems' name, problems' code, and problems' classification.

Research methodology:

here are many research methods, however the most of them fall under two basic types of research approaches: Qualitative and Quantitative. Determination of the research methodology to be used depends on the purpose of the study and the type and availability of required information [17]. As the main objective of this research is to " investigate the problematic issues that facing the CMM process in Libyan construction projects", which needs a large-scale investigation from the study area, the "Quantitative Approach" has been used in this research. It is an appropriate approach to collecting

data from large areas with a large number and at the lowest cost [11] [8] [9].

Table 4: Classification of the Problems of the CMM Process

CMM FUNCTION	PROBLEM CODE	CMM PROBLEMS
PLANING	PP1	Lack of proper work plan within & between the CMM functions
	PP2	Improper selection of the contract type for materials procurement
	PP3	Multiple changes of owner's mind
	PP4	Lack of an effective communication system between parties involved
	PP5	Materials definition problems
MATERIAL TAKEOFF & DESIGN INTERFACE	PD1	Excessive bureaucracy by the owner in administrative procedures
	PD2	Problems related to "Tendering"
	PD3	Problems related to "Designs"
	PD4	Successive changes in approved design .
	PD5	Problems related to submittals
	PD6	Failure to estimate the quantity of materials required
MATERIAL PROCUREMENT & TRANSPORTATION	PT1	Problems related to material delivery.
	PT2	Problems related to "Supply/Logistic Of Building Material & Equipment"
	PT3	Weakness of Vendor/supplier evaluation criteria
	PT4	Unrealistic delivery dates,
	PT5	Lack of using the delivery tracking system
	PT6	Problems related to specifications
	PT7	Problems related to "Finance Issues"
	PT8	Unavailability of materials required
	PT9	Ambiguity of requirements
QUALITY MANAGEMENT	PQ1	Restriction of some CMM activities /operations due to quality considerations
	PQ2	Lack of quality assurance from supplier
	PQ3	Absence of a good system for field quality inspection
WAREHOUSING	PW1	Absence of sound management of surplus materials
	PW2	Lack of Inventory Material Control & Update Material-Inputs
	PW3	Lack of conformance to requirements; Materials rejected due to non-compliance
	PW4	Problems related to storage area and conditions
	PW5	Poor protection against many threats (theft, Stealing , damage or loss),
	PW6	Delays in inventory examination
FIELD CONTROL	PF1	Problems related site layout & Loading area
	PF2	The waste Disposal
	PF3	Inadequate health and safety procedures for the accidents might be occurred.
	PF4	Poor materials management among sub-contractors
	PF5	Lack of storage space on the site (Storage Scope on site)
	PF6	Re-action due to field errors

CMM FUNCTION	PROBLEM CODE	CMM PROBLEMS
	PF7	Improper control system to record material availability information within construction stage

Data collection process/technique:

Literature review: It was drawn from related thesis, journals, papers and researches' reports. The review of these literature aimed to report recent studies in this area in order to understand CMM process, identify theoretical problems in managing construction materials, and classify these problems based on the CMM function that they may occur into its activities.

Questionnaire Survey (Quantitative): A "Handed Questionnaire" survey was administered to a sample of CMM related experts, who are working on the Libyan construction projects. It was designed on the basis of the findings obtained from the literature review in theoretical studies, and its questions were formulated to evaluate the CMM problems in terms of the severity of their impact (their importance) in managing construction projects in the capital of Tripoli, and their frequent of occurrence on those projects.

Mechanism of data collection and analysis techniques:

A total of 42 questionnaires were delivered to specialized experts, but only 35 of them were received from the respondents. In the analysis process, only 30 questionnaires were used, as five questionnaires were removed, either because of the lack of logic in the majority of answers or their incomplete or the loss or unreturned of some answering sheets. In order to provide robust and structured analysis, a statistical software package (SPSS 22) was used to analyse the questionnaire data.

For the purpose of evaluating and arranging variables (CMM problems), "Descriptive Statistics Analysis" was practiced to analyse the results of the questionnaires, as it deals mainly with the evaluation and arrangement of variables, in addition to its ease and ability to represent data appropriately [18]. Because of their validity, reliability and ability to draw inferential differences between the

arrangement of variables or elements, both the “Mean Score” and the “Median Value” were used to rank the CMM problems according to their importance and frequency. They are recommended by many researchers as they give a more holistic perspective in describing and evaluating a group of elements [43].

To conduct this evaluation, the respondents were asked to use a five-point Likert Scale for selecting the appropriate option relating to the assessment of the relative importance of the CMM problems (1=Not Important, 2=Slightly Important, 3=Moderately Important, 4= Very Important, and 5=Extremely Important), and of their frequency of occurrence (1=Never Occurs, 2=Rare occurrence, 3=Occasionally, 4=Usually Occurs, and 5=Always Occurs).

Analysis and discussion of the outputs:

Respondents background information:

The analysis of the first section of the questionnaire aims to obtain data comprising personal information of the respondents including their current position/title, years of experience, the type of their organisation and the projects they are currently working on, along with the perspective that was chosen to answer the questionnaire. **The Figure 3** illustrates that the “Project Manager”, “Consultant Engineer”, and Materials related personnel groups were the largest of the respondents, whereby they represented 30%, 25% and 25% of the respondents respectively. The remaining percentage of respondents was distributed as following; 10% Project Planning Engineer, 5% Executive Director, and 5% Construction Site Manager.

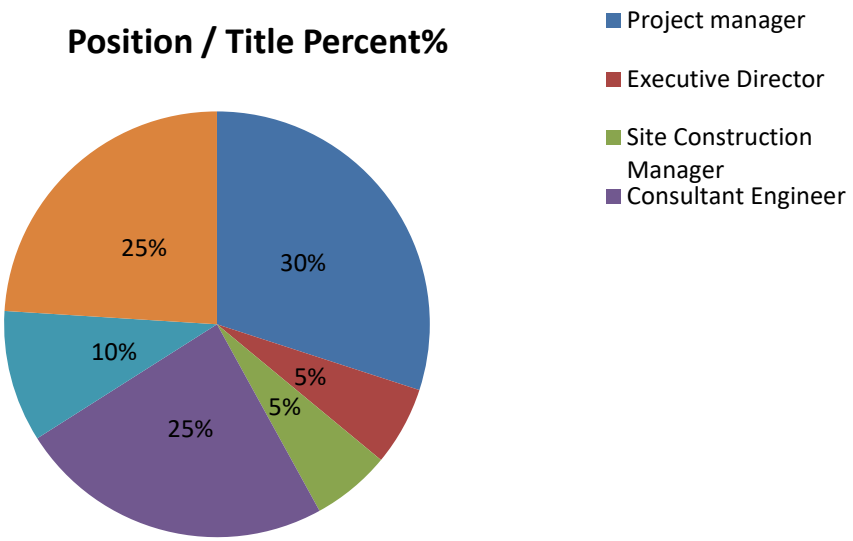

Figure3: The Percentage of Respondents' Position Title

The Figure 4 illustrates the experience of the respondents in the areas related to building materials management within the Libyan Construction Industry (L.C.I). Where, the results demonstrate that about two-third of respondents claimed that have more than ten years' experience working within the L.C.I; 35% between 11- 15 years, 20% between 16-20 years and 10% more than 25 years, while only 25% of the respondents have experience between 5-10 years and 10% have less than 5 years' experience of working within the L.C.I.

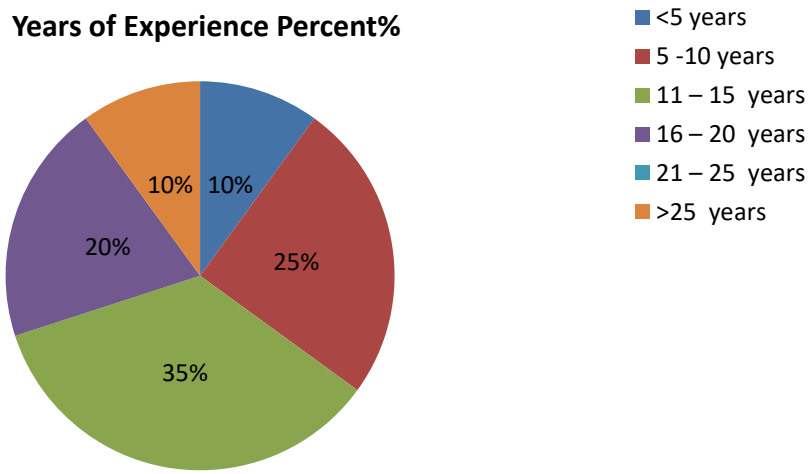

Figure 4: The Percentage of Respondents' Experience Years

With such long experience in areas related to CMM within L.C.I, in addition to the diversity of the construction site's types, one can say that the information gathered was reasonably reliable, since the involvement of experienced professionals in the survey can increase the validity and reliability of the results, and thus the validity and reliability of the entire study.

Performance of Libyan Construction Projects:

With regard to the performance of the Libyan construction projects implemented by the "Municipality of Tripoli", in which the respondents participated during the period of time before and until 2011, the respondents were asked to answer two questions;" how many projects have they participated in L.C.I"? and "how many projects of those have been delayed due to problems related CMM?. For analysing this section a "Cross-Tabulation Technic" is used. The results obtained from the questionnaire and summarized in **Table 5** reveal that nearly half of the respondents (40%) participated in more than 25 Libyan construction projects. Of these, 62.5% (i.e. 25% of the respondents) acknowledged that there were delays due to poor CMM in the whole projects in which they participated.

Table 5: Relationship between the projects practiced and delayed

Number of Projects participated in	Number of Projects Delayed					Total
	<5	10-5	15-11	20-16	>25	
5-10	5%	10%	10%	0%	0%	25%
11-15	0%	5%	10%	0%	0%	15%
16-20	5%	5%	0%	5%	5%	20%
>25	5%	0%	5%	5%	25%	40%
Total	**15%**	**20%**	**25%**	**10%**	**30%**	**100%**

This result might prove to every insightful person the importance of this study, which aims to determine and evaluate the problems face by the CMM process within the L.C.I. This might be considered as the first step in mitigating or avoiding these problems during practicing the Libyan building projects, in order to be completed on time, within the expected cost and according to the required specifications.

Evaluation of problems of the CMM process:

This represents the main axis of the questionnaire, and was designed to evaluate the 36 CMM problems that obtained from the in-depth theoretical study in this research. The evaluation includes assessing these problems in terms of their importance and frequency of occurrence in the construction projects into the case study area (Tripoli).

Evaluation of the CMM problems related to "Planning" function:

Examination of the **Table 6** provides an evaluation of the importance and frequency of each CMM problems related to planning function based on the mean scores and median values. Three problems of the five related to the planning function (PP4, PP3, PP1) had the same median value of "5", and this means that they had the same level of severity of importance (Extremely Important), however, they differ in their mean score. It can be noted that "PP4: Lack of an effective communication system between parties involved" had the highest mean score with 4.35, and then followed by "PP3: Multiple changes of owner's mind" and "PP1: Lack of proper work plan within & between the CMM functions" with mean scores of 4.15 and 4.05 respectively. The least important problem is "PP5: Materials definition problems" with a mean score of 2.25.

Table 6: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Planning Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency evaluation		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PP4	4.35	5	PP4	4.35	5
2	PP3	4.15	5	PP1	3.95	4
3	PP1	.405	5	PP3	3.45	3
4	PP2	2.95	3	PP2	2.70	3
5	PP5	2.25	2	PP5	2.25	2

Regarding the evaluation of CMM problems –related to planning function according to the frequency of their occurrence, **Table 6** shows that the problem of "PP4: Lack of an effective communication system between parties involved" had also the highest mean score with 4.35, which means that it is the most frequent problems occurring within the planning function. This indicates to the extent of the influence of this problem in managing construction projects, and this supports what was reported by the chairman of the Jordanian Construction Contractors Association (JCCA); "*poor communication between the subcontractors and the other project's parties has significant influence in completing any building project*" [19]. The rest of problems had median values between 4-2 as demonstrated in **Table 6**.

Evaluation of the CMM Problems related to "Take-off" function:

Ranking the CMM problems related "MATERIAL TAKE OFF & DESIGN INTERFACE" function is listed in **Table 7.** The survey shows that the entire CMM problems related to "Take-off" function had the same ranking order in terms of the both of their importance and frequency with a median value of 4 (very important) for the most majority of them. **Table 7** illustrates that "PD3: Problems related to Designs" are the most important and the most frequent problems of those related to the function of "Take-off" function. This is followed by; "PD1:Excessive bureaucracy by the owner in administrative procedures", "PD4:Successive changes in approved design", "PD6:Failure to estimate the quantity of materials

required", and "PD5:Problems related to submittals". The Problems related to "Tendering" are considered as the least important and frequent of occurrence within the Libyan construction projects with a main score of 2.55 and a median value of 2.70.

Table 7: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Take-off Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency evaluation		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PD3	4.35	5	PD3	4.10	4
2	PD1	3.95	4	PD1	3.95	4
3	PD4	3.80	4	PD4	3.75	4
4	PD6	3.80	4	PD6	3.55	4
5	PD5	2.90	3	PD5	3.15	3
6	PD2	2.55	3	PD2	2.70	3

Based on the fact that the importance of the problems of a process reflects the importance of the activities that included in that process, the findings above interprets the extent of importance of Take-off Function. This is consistent with the view of the most CMM related specialists, who believe that the function of "Material Take-off and Design Interface" is the first practical function in the CMM process where the real estimation of the quantity of materials required is done [24].

Evaluation of the CMM Problems related to "Procurement" function:

Table 8 presents a comparison of the importance ranking with the frequency ranking of the CMM – problems related to "Material Procurement & Transportation" function by the means score and median value. Excepting "PT6: Problems related to specifications", there is clear convergence in importance-ranking and frequency-ranking between the rest of the CMM problems related to "Procurement" function.

Table 8 reports that the most important and the most frequent CCM problem related to "Procurement" function is "PT1:Problems related to material delivery" with a value score of 5 (Extremely Important" and a mean score of 4.60 for both the importance and

frequency ranking. This confirms the findings that was revealed by [42] and [37] and many others.

Table 8: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Procurement Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency evaluation		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PT1	4.60	5	PT1	4.60	5
2	PT2	4.15	4	PT6	4.25	4
3	PT4	4.15	4	PT2	4.15	4
4	PT6	3.95	4	PT4	4.15	4
5	PT8	3.65	4	PT8	3.30	3
6	PT7	3.55	4	PT7	3.05	3
7	PT3	3.15	3	PT5	3.00	3
8	PT5	3.00	3	PT3	2.90	3
9	PT9	2.55	3	PT9	2.30	2

Based on their mean scores and median value, the remaining CMM problems related to Procurement function have been ranked (in a descending order) from the most important to the least important as follows; PT2:Problems related to "Supply/Logistic Of Building Material & Equipment", "PT4:Unrealistic delivery dates", "PT6:Problems related to specifications", "PT8:Unavailability of materials required", "PT7:Problems related to "Finance Issues", "PT3:Weakness of Vendor/supplier evaluation criteria", "PT5:Lack of using the delivery tracking system", and the least important and the least frequency was "PT9: Ambiguity of requirements" with a mean score of 2.55 and 230 for the importance ranking and frequency ranking respectively.

Evaluation of the CMM problems related to "Quality" function:

Table 9 gives details about ranking the importance of the CMM problems related to "Quality Management" function and their frequency based the mean score and the median value. Examination of the relationship between the importance and the frequency of the CMM problems above discovers that although "PQ2:Lack of quality assurance from supplier" is the most important CMM problem of

those related to Quality Management function, it is the least frequent CMM problems (with mean score of 3.55; 2.65 respectively). Similarly, whereas, "PQ3: Absence of a good system for field quality inspection" is the most frequent CMM problem related to Quality Management function, it is the least important one of them (with mean score of 3.35; 2.65 respectively).

Table 9: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Quality Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency evaluation		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PQ2	3.55	4	PQ3	3.35	4
2	PQ1	3.40	4	PQ1	3.15	3
3	PQ3	2.65	3	PQ2	2.65	3

The above findings could provide a strong support to what was discovered by [11] that although there is a clear relationship and association between the importance and frequency of problems, the extent of the importance of a problem in managing a construction project does not always express the extent of the frequency of its occurrence within the Libyan building projects.

Evaluation of the CMM problems related to "Warehousing" function:

Given **Table 10**, one can see that the importance ranking is somewhat close or slightly similar to the frequency ranking for the most of the measures. As noted from the table, four of the six CMM problems related to "Warehousing" function had highest median value with 4 (Very Important), and they ranked based on their mean scores as following; "PW3:Lack of conformance to requirements; Materials rejected due to non-compliance" (3.90), "PW2:Lack of Inventory Material Control & Update Material-Inputs" (3.60), "PW5:Poor protection against many threats (theft, Stealing , damage or loss)" (3.55), "PW6:Delays in inventory examination" (3.50), "PW1:Absence of sound management of surplus materials" (2.40)

and the least important CMM problem is “PW4:Problems related to storage area and conditions” with a mean score of 2.10.

Table 10: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Warehousing Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency evaluation		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PW3	3.90	4	PW2	3.40	4
2	PW2	3.60	4	PW3	3.35	4
3	PW5	3.55	4	PW5	3.25	4
4	PW6	3.50	4	PW6	3.20	3
5	PW1	2.40	2	PW1	2.55	3
6	PW4	2.10	2	PW4	2.35	2

With regard to assessing the CMM problems related to the warehousing function in terms of their occurrence in Libyan construction projects, excepting the problems PW2 and PW3, the rest of the problems ranked with same order of their importance.

Evaluation of the CMM problems related to “Field Control” function:

As in the evaluation of the previous CMM problems, **Table 11** show the results of assessment of the problems related to the “Field Control” function in terms of the severity of their importance and the frequency of their occurrence.

Table 11: A Comparison of the Importance Ranking with the Frequency Ranking of the CMM – problems related to Field Control Function by the Means Score and Median Value

RANK	Importance evaluation			Frequency		
	CMM Problem Code	Main	Median	CMM Problem Code	Main	Median
1	PF2	4.30	5	PF2	3.95	4
2	PF6	3.90	4	PF4	3.45	4
3	PF4	3.70	4	PF1	3.40	4
4	PF1	3.45	4	PF6	3.30	3
5	PF7	3.25	3	PF7	3.25	3
6	PF5	3.20	3	PF5	3.20	3
7	PF3	2.60	3	PF3	2.20	2

From the point of view of the respondents, the problem of "PF2: The waste Disposal" is the most important and the most frequency (with mean scores of 4.30 and 3.95 respectively) and the problem of "PF3: Inadequate health and safety procedures" is the least important and the least frequency (with mean scores of 2.60 and 2.20 respectively) occur within the function of field control in the CMM process in the Libyan construction projects in the case study of Tripoli. This result is inconsistent with what was reached in the study conducted by Gulghane and Khandve [37], which considers that improper site layout is the most important problem could be faced within the function of field control.

Conclusion and recommendation

As mentioned above, various literature studies illustrated the importance of materials management and highlighted how it became the process that determines the project success in construction as it does in manufacturing. However, although there are some references on investigating the problematic issues of the supply chain management and its performance in the manufacturing industry, they are still very limited to the construction industry, and they might be absent from the Libyan Construction Industry (L.C.I), where no relevant references could be found. Therefore, there is a pressing need for identifying the problematic issues that faced by the CMM process and assessing and analysing their impact on the success of the Libyan construction projects and the investments in the overall L.C.I.

The significance of this research emerges from its contribution to bridging the gap(s) that can be found in the previous studies, knowledge, or practical professional life. The study provides an original approach to develop a set of construction materials management problems and classify them on the basis of the CMM function that they may occur into its activities. This was followed by an evaluation of those CMM problems in terms of their importance and frequency of occurrence in Libyan construction projects-Tripoli as case study. This thus represents a major contribution to the knowledge and society.

The in-depth literature review discovered a set of **36** problems that embody the most recognised problems and obstacles that impeding the optimum CMM process. These problems were classified into **6** functions of the CMM process; Planning, Material Take-off & Design Interface, Material Procurement & Transportation, Quality Management, Warehousing and Field Control. Through the use of the quantitative approach (a questionnaire) and electronic analysis technique, the severity of the CMM problems and the frequency of their occurrence in the Libyan construction projects were evaluated in the case of the study Tripoli.

Evidently, the most building projects in Tripoli have been delayed due to problems related to CMM process. The majority of the CMM problems are very important and usually occur within the Libyan construction projects. This can be clearly interpreted from the median values that obtained by the CMM problems, which were between 4= Very Important, and 5=Extremely Important; 4=Usually Occurs, and 5=Always Occurs. Based on their mean scores, the CMM problems that are faced by CMM process within the L.C.I were ranked into their categories. It can be concluded that the overall six most important CMM problems over the entire six categories (functions) are, “PT1: Problems related to material delivery”, “PD3: Problems related to “Designs”, PP4: Lack of an effective communication system between parties involved”, “PF3: The waste Disposal”, “PW3: Lack of conformance to requirements; Materials rejected due to non-compliance”, and “PQ2: Lack of quality assurance from supplier”. With regard to overall evaluating the CMM problems over the entire six categories, in terms of their frequency of occurrence, excepting the problems PQ2 and PW3, the rest of the problems ranked with same order of their importance.

Finally, the urgent need to determine the CMM problems in the Libyan construction projects and the lack of research studies in this field in the Arabic Area in general and Libya in particular, shows the importance of this study through the contribution that it can make to knowledge and society. The research findings provide a basis for additional work to further enhance the materials management practices, and to encourages Arab researchers to enter

the field and create more developed techniques for monitoring and evaluating the CMM process from different dimensions. It is recommended to give adequate time and financial resources for conducting a wider investigation; involving bigger number of building projects (case studies) and larger size sample, for obtaining a broader and clearer picture of the problems in terms of managing construction materials and producing more reliable findings and validation of data.

References:

[1]- Wegelius-Lehtonen, T. (2001). Performance Measurement in Construction Logistics. *Int. J. Production Economics*, **69** (2001), 107-116. Article from Elsevier Science.

[2]- Hassan, P. (2005). A best Practice Framework for Training UK Construction Site Managers. PhD Thesis, Department of Development and Society, Sheffield Hallam University.

[3]- Newcomb, R., Langford, D. and Fellows R. (1993) Construction Management: Organisation Systems. London, B. T. Batsford.

[4]- Beatham, S., et al. (2004) A critical appraisal of their use in construction benchmarking. *An International Journal*, **11** (1), 93–117.

[5]- Fryer, B. (2004). The Practice of Construction Management. 4th ed. Oxford, Blackwell Publishing.

[6]- Griffith, A. and Watson, P. (2004) *Construction Management Principles and Practice*. Basingstoke, Palgrave Macmillan.

[7]- Nudurupati, S., Arshad, T. and Turner, T. (2007). Performance measurement in the construction industry: An action case investigate manufacturing methodologies. *Computers in Industry*, **58**, 667-676. Article from Elsevier B.V

[8]- Construction Industry Institute (CII) (1987). Project materials management planning guide-Handbook. Austin, Materials Management Task Force, (Doc. 27, 83-7).

[9]- Stukhart, G. (1995). Construction Materials Management. New York, Marcel Dekker Inc.

[10]- K.V. Patel, C.M. Vyas. (2011). "Construction Material Management on Project Sites", *National Conference on Recent Tends in Engineering and Technology*. 13-14 May 2011, B.V.M. Engineering College, V.V.Nagar, Gujarat, India

[11] – محمد الزغبي ، عماد دوحة، عيسى الاشهب(2019). "تحقيق في أسباب التأخير في المشاريع الانشائية الليبية– حالة الدراسة العاصمة طرابلس". *المؤتمر الدولي للعلوم والتكنولوجيا*، 4–6 2019، طرابلس، ليبيا.

[12]- Al-Darweesh, A. (1999). measuring the effectiveness of materials management for Industrial Construction Projects in Saudi Management, King Fahd University of Petroleum and Materials, Dhahran, Saudi Arabia

[13]- Yang, J. L, Edwards, D. and Nicholas, J. (2003). A fuzzy logic decision support system for routing materials on construction sites, *International Journal of IT in Architecture, Engineering and Construction*, **1** (4), 293-305.

[14]- AL-quriesha, A. A., Bello, M. and Fallatah, Y. (2006). Evaluation of Performance Measures for Materials Management Process in Industrial Construction Project, *King Fahd University of Petroleum and Materials: Construction Contracting & Management*, **CEM-520**, 2-18.

[15]- AL-Alawi, F., AL-ghazwi, A. and AL-Saeed, I. (2007) Evaluation of performance measures for materials management process in industrial construction project, *Construction Contracting & Management (K F U P M)*, 2-12

[16]- Business Roundtable (BRT). (1982). Modern management systems. A construction Industry cost effectiveness project report A-6**,** New York, Business Roundtable.

[17]- Plemmons, J. K. (1995). Materials management process measures and benchmarking in the industrial construction industry. PhD thesis, Clemson University, Clemson, S.C.

[18]- Formoso, C.T. and Revelo, V.H. (1999). Improving the materials supply system in small-sized building firms. *Automation in Construction*, **8**, 663–670. Frankfort

[19]- ALzohbi, M. (2015). I, A framework for evaluating materials management performance in Jordanian Concrete Building Projects. PhD Thesis, Department of Development and Society, Sheffield Hallam University, Sheffield.

[20]- Muehlhausen, F. B., (1991). Construction sites utilisation: impact of material movement and storage on productivity and cost. T*he American Association of Cost Engineering (AACE) Transaction*, 1991 L-2, pp1-9.

[21]- Marsh, J.W. (1985). Material management: a practical application in the construction industry. *Cost Engineering*, **27** (8), 18-28.

[22]- Perdomo-Rivera, J.L. (2004). A framework for A decision support model for supply chain management in the construction industry. PhD Thesis. Faculty of the Virginia Polytechnic Institute and State University, Blacksburg: Virginia.

[23]- AL-Haddad, E.E. (2006). A construction materials management system for Gaza Strip Building Contractors. MSc Thesis, Faculty of Engineering Construction Management Program, the Islamic University of Gaza, Gaza, Palestine

[24]- Bintikasim, N. (2008) Improving Materials Management on Construction Projects. PhD Thesis, School of Civil Engineering, Loughborough University, Loughborough

[25]- Alzohbi, M. G., Stephenson. P, and Griffith, A. (2011) An Investigation of problematic issues associated with site management – The case study of Great Man-made River Projects in Libya. ARCOM Workshop: *Association of Research in Construction Management*, **28** (2), 12-23.

[26]- Edum-fotwe, F. T., Thorpe, A. and Mccaffer, R. (1999). Organisational relationships within the construction supply-chain. In: *Proceedings of a Joint CIB Triennial Symposium*. Cape Town.

[27]- Hatmoko, J. (2008). The impact of supply chain management practice on construction project performance. PhD Thesis, School of Civil Engineering and Geosciences Newcastle University, Newcastle

[28]- Muya, M. (1999). A systematic approach for improving construction material management logistic. PhD Thesis; Loughborough University, Loughborough.

[29]- Najmi, H.S. (2011). Project Management for Construction Projects. MSc Thesis, Engineering Management at Faculty of Graduate Studies, An-Najah National University, Nablus, Palestine

[30]- Bell, L. C. and Stukhart, G. (1986). Attributes of materials management system. *Journal of Construction Engineering and Management*, **112** (1), 14-22.

[31]- Construction Industry Institute (CII). (1988). Project Materials Management Primer. Austin, University of Texas, Materials Management Task Force, (Publication 7-2).

[32]- Coyle, J. J. Bardi, E. J. and Langley, C. J. (1996). The Management of Business Logistics. 6th ed. Minneapolis; St. Paul, Western Publishing Company.

[33]- AL-Juaid, M. A. (2005). Measuring the effectiveness of materials management for industrial projects, *King Fahd University of Petroleum and Materials*, **CEM-520**, 1-22.

[34]- UL-Asad, M. K. (2005). Evaluation of Performance Measures for Materials Management process in Industrial Construction Projects, MSc Thesis, School of Construction Engineering and Management, King Fahd University of Petroleum and Materials, Dhahran, Saudi Arabia.

[35]- Nasir, H. (2008). A model for automated construction materials tracking. MSc Thesis, Faculty of Civil Engineering, University of Waterloo, Waterloo: Canada

[36]- Patel, K.V. and Vyas. C.M. (2011). Construction materials management on project sites. In: *National Conference on Recent Trends in Engineering & Technology*, Gujarat, 13-14 May 2011. Gujarat, India, B.V.M. Engineering College

[37]- Gulghane, A. A. and Khandve, P. V. (2015). Management for construction materials and control of construction waste in construction industry: A review. *Int. Journal of Engineering Research and Applications*, **5** (4), 59-64 .

[38]- Zakeri, M., Olomolaiye ,P., Holt, G.D., and Harris F.C. (1996). "A urvey of constraints on Iranian construction operatives' productivity" *Journal of Construction Management and Economics*,. **14**.(5), 417-426.

[39]- Dey P, K. (2000). Managing projects in fast track: A case of public sector organisation in India. *International Journal of Public Sector Management*, 13(7), 588-609.

[40]- Kasim, N.B., Anumba, C.J., Dainty, A.R.J. (2005). "Improving materials management practices on fast-track construction projects", 21st *Annual ARCOM Conference*, 7-9 September 2005, SOAS, University of London, vol. **2**, pp. 793-802.

[41]- Narimah, N. (2011). " ICT Implementation for materials management in construction projects: Case studies", *KICEM Journal of Construction Engineering and Project Management*, 14-22.

[42]- Ramaraj, P. (2014). Construction Material Management. Shanmugapriya, Sundarjan.

[43]- ALzohbi, M., Gergab, L., And Stephenson, P. (2018). "Problems and obstacles which constrain the optimal construction site management into Libyan Large-Scale Projects", *Journal of Pure & Applied Sciences*, **17**.(1), 417-426.