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Term Paper:

Measuring the Effectiveness of Materials Management

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This paper is written by Mazen A. Al-Juaid, as an exposition for the thesis titled "Measuring the Effectiveness of Materials Management for Industrial Construction Projects in Saudi Arabia", by Ali Al-Darweesh.

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ABSTRACT

Material Management is the subject of the study done by Ali Al-Darweesh in his thesis titled “Measuring the Effectiveness of Materials Management for Industrial Construction Projects in Saudi Arabia”. In this paper, I am trying to give an overview for his valuable work. For long time, Material Management has been an obsession for project engineers. Workers in construction area have always tried to reduce time and money consumed by materials. In order to do that, they have tried to come up with a measuring and then updating procedures to check and then correct the status of a material system. However, it is not easy to do so!. Ali tried to come up with a method that can be used in construction area to check the efficiency of the material system. In the thesis, Ali exposed the reader to much of clarifications and information about material management process, and material management functions. After that, he explained the model, the data, and the analysis. He used in his model a number of projects in Saudi Arabia, then he used his method to rank the project in terms of their material management systems. At the end, he offered his recommendations.

1. INTRODUCTION

Material Management can be defined as; "The planning and controlling of all 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" [1].

Project materials management should be thought of as a process rather than an organization. In fact, the activities of the materials cycle cross all organizational lines of the project and begin with the specification of the material which is primarily the responsibility of the owner and engineer [2].

Material management is a system that includes all the functions of acquiring and distributing the materials and equipment to support construction. The objectives of this system include:

- Obtaining the best value for purchased materials,
- Assuring supplies are on hand when and where required,
- Reducing inventory to the lowest amount required,
- Assuring quality requirements are met, and
- Providing efficient, low cost transport, security, and storage of materials at construction sites [2].

2. PREVIOUS STUDIES

Previous studies show that materials constitute about 60% of total project cost, and control 80% of the project schedule. Based on 5.5% profit of project cost, a 2% reduction in materials cost will increase profit by 21%. As well they show that availability of materials, improvement in labor productivity, and reduction in material surplus are advantages of having a material management system. [7]

3. OBJECTIVES

1. To utilize an effectiveness-measuring model for materials management for industrial projects in Saudi Arabia.

2. To measure the effectiveness of the materials management process of the industrial projects of construction companies operating in Saudi Arabia.

3. To use result of the study as a basis for benchmarking future projects

4. LIMITATIONS

This study is limited to the industrial projects in the Eastern Province. These projects include industrial plants, refinery and petrochemical plants, oil and gas pipelines; and water desalination.

5. MATERIAL MANAGEMENT FUNCTIONS

Material management functions are materials takeoff, purchasing, quality management, expediting, shipping, receiving, warehousing
housing, and issue.

- Materials takeoff is identifying what materials are needed and how much.
- Purchasing concerns the establishment of forms and procedures to purchase materials; developing standards terms and conditions; issuing request for quotations; evaluating bids; price and contract negotiations; preparing and administrating purchase orders; and executing close outer activities, including surplus disposal. Addressing

claims and back charges, and records storage [3].

- Quality management is translating used needs into specifications and project quality plans and programs with clear statement of quality control.
- Expediting is to insure that materials are delivered to the construction site on time.
- Shipping is transporting materials in the most timely, most cost effective and safest manner possible in order to complement construction schedule requirements [2].
- Warehousing is the implementation of advanced techniques and technologies to optimize all functions throughout the warehouse.

6. MATERIAL MANAGEMENT MEASUREMENTS

Measurements are key to controlling, managing, and improving any work process. Without measurements, documenting and benchmarking the impact of intentional changes or improvements is limited [3].

We can identify three process measures, Efficiency, Adaptability, and Effectiveness;

6.1. Efficiency

which is the extent to which recourses are minimized and waste eliminated in the pursuit of effectiveness.

6.2. Adaptability

which is the flexibility of a process to handle future.

6.3 Effectiveness

which is having the right output at the right place, at the right time, at the right price [3].

7. PROCESS MEASUREMENTS CATEGORIES

Six attributes of performance for the materials management process were identified by Plemmons, accuracy, quality, quantity, timeliness, cost and availability.

7.1. Accuracy

It is the degree to which an item of information is true or false [3].

7.2. Quality

It is the degree to which a system conforms to requirements, specifications, or expectations an considered an outcome of an organizational system [4].

7.3. Quantity

It measures evaluate the process flow or throughput in terms of volume or quantities related to planned accomplishment [3].

7.4. Timeliness

It is the measurable interval between two events or the period during which some activity occurs.

7.5. Cost

Cost characteristics define the process in terms of meeting planned cost and labor targets [3].

7.6. Availability

It measures the ability of the materials management process to fill requests for materials as the agreed time and place [3].

8. BENCHMARKING

The International Benchmarking Clearinghouse defines benchmarking as "the practice of being humble enough to admit that someone else is better at something and being wise enough to try to learn how to match and even surpass them at it" [5].

According to Willborn and Cheng (1994), some of the lessons that result from benchmarking include:

- Stretch goals can be met.
- Both product and service quality must be improved.
- Not only does the company have to serve a customer, everyone in the company has to satisfy a customer internal in the company.
- Clear ownership of multifunctional process must be assigned.
- Management and staff must realize how much work is required and which risks need to be taken.

Benchmarking can be divided into three types, competitive, functional, and internal benchmarking.

8.1. Competitive Benchmarking

Is an approach that studies product designs, processes, capabilities, or administrative methods used by business competitor.

8.2. Functional Benchmarking

Is performed with non-competitors. The goal of functional benchmarking is to improve an organization's processes through implementing new process enabler rather than from learning a competitor's abilities.

8.3. Internal Benchmarking

It attempts to find study partners within the same organization.

Benchmarking consists of four primary steps; plan, collect, analyze, and improve.

- Plan step addresses the planning of a benchmarking project.
- Collect step involves those activities primarily associated with the collection of data.
- Analyze step is related to the comparative data and the performance gaps and enablers. Enablers are those processes, practices, or methods that produce the best-in-class performance.
- During improve step, the applicable process enablers and best practices are integrated into company operations.

9. RESEARCH METHODOLOGY

Data collection process had targeted the ongoing projects in Al-Jubail industrial area within the period from 1998 to 1999.

A total of 17 projects had responded. See table 1.

Table 1
Projects List

S/N	Project Type	Project Duration in Months	Project % Completion	Project Contract Type	Project Value In US $
1-	Industrial	25-48	75-100	Lump Sum	>401 M
2-	Petrochemical	1-12	26-49	Lump Sum	<100 M
3-	Petrochemical	25-48	50-74	Lump Sum	>401 M
4-	Petrochemical	13-24	75-100	Lump Sum	101-200 M
5-	Petrochemical	25-48	75-100	Lump Sum	101-200 M
6-	Petrochemical	25-48	75-100	Lump Sum	201-300 M
7-	Petrochemical	25-48	75-100	Lump Sum	301-400 M
8-	Petrochemical	25-48	50-74	Lump Sum	201-300 M
9-	Refinery	13-24	50-74	Lump Sum	<100 M
10-	Oil & Gas	25-48	75-100	Lump Sum	101-200 M
11-	Oil & Gas	25-48	50-74	Lump Sum	101-200 M
12-	Oil & Gas	13-24	75-100	Lump Sum	<100 M
13-	Oil & Gas	>49	75-100	Lump Sum	101-200 M
14-	Oil & Gas	13-24	75-100	Lump Sum	<100 M
15-	Oil & Gas	13-24	75-100	Lump Sum	<100 M
16-	Oil & Gas	25-48	75-100	Lump Sum	<100 M
17-	Petrochemical	13-24	26-49	Lump Sum	<100 M

Table 2 shows the model used to collect the data. This model shows the 12 key measures that are related to the lump sum type of contract.

Table 2
The measuring model

Type of industrial project	
Type of contract	
Duration in months	
Project value $	
% of completion	

ACCURACY (AC)		
1. Material receipt problem (AC1)	Line Items Received Without Discrepancies LIRND	
	Line Items Received With Discrepancies LIRWD	
	AC1 = (LIRND/(LIRND+LIRWD))*100	
2. Warehouse inventory accuracy (AC3)	No. of random items to be counted (ITC)	
	No. of random items found accurate (IFA)	
	AC3 = (IFA/ITC)*100	
AVAILABILITY (AV)		
3. Materials availability (AV1)	Total number of line items issued (LII)	
	Total number of line items requested (LIR)	
	AV1 = (LII/LIR)*100	
QUALITY (Q)		

4. Jobsite rejections of tagged equipment (Q2)	No. of tagged equipment (NTQ)	
	No. of tagged equipment rejected (NTQR)	
	Q2 = (NTQR/NTQ)*100	
TIMELINESS (T)		
5. Procurement lead time (T1)	Average Actual procurement lead time (AALT)	
	Average Planned procurement lead time (APLT)	
	T1 = [(AALT-APLT)/APLT]*100	
6. Bid/evaluate/commit lead time (T1)	Average Actual BEC lead time (ABECLT)	
	Average Planned BEC lead time (PBECLT)	
	T2 = [(ABECLT-PBECLT)/PBECLT]*100	
7. PO to materials receipt duration (T3)	Average actual receipt duration AMRD	
	Average Planned receipt duration PMRD	
	T3 = [(AMRD-PMRD)/PMRD]*100	
8. Materials receiving processing time (T4)	Average materials received in same day (MRSD)	
	Average materials received in next day (MRND)	
	T4 = [(MRSD-MRND)/MRND]*100	
9. Commodity vendor timeliness (T5)	No. of on time promised deliveries (OTPD)	

	Total no of deliveries (TD)	
	T5 = (OTPD/TD)*100	
10. Materials withdrawal request MWR leadtime T7	Average MWR lead time AMWR	
	Planned MWR lead time PMWR	
	T7 = [(AMWR-PMWR)/PMWR]*100	
COST (C)		
11. Construction time lost C5	Construction time lost CTL	
	Construction time CT	
	C5 = (CTL/CT)*100	
12. Total surplus C11	Value of unused material VUM	
	Value of total purchased materials VTPM	
	C11 = (VUM/VTPM)*100	

10. DATA ANALYSIS

Table 3 shows the weight and some details about each one of the key measures used in the model. The first column in the table represents the key measure number, while second column lists the description of the 12 key measures. The third column represents the weight or the response rate of the key measure as identified by Plemmons. The fourth column, titled " no. of projects" represents the number of responded projects to the particular key measure. The fifth and the sixth columns represent the average and the standard deviation respectively for each key measure. Finally, the seventh and the eighth columns list the highest and the lowest value of each key measure.

The key measures have been divided into two groups A and B. Group A represents measures that are considered best when are as low as possible. Group B represents measures that are considered best when they are as high as possible.

Group A includes: jobsite rejections of tagged equipment, piping spool rework, procurement lead time, bid/evaluate/commit lead time, PO to materials receipt duration, materials receiving processing time, materials withdrawal request lead time, construction time lost, and total surplus. While group B includes; materials receipt problem; warehouse inventory accuracy, materials availability, commodity vendor timeliness, and commodity timeliness.

Using those key measures, ranking the projects is possible. This would enable project management from comparing theirs with others and make benchmarking seem viable.

The average value for group A measures were added for the projects and were ranked in ascending order of their total score. The lower the score the project had, the higher ranking it achieves. Consequently, the project with the lowest score is considered the best.

Table 3
Projects summary result

S/N	Key Measures	Weight	No. of projects	Average	Std deviation	The highest	The lowest
1	Material receipt problem AC1	33%	16	97	5.4	100	80
2	Warehouse inventory accuracy AC3	25%	10	92	7	100	80
3	Material availability AV1	67%	15	95	4.6	100	86.33
4	Commodity vendor timeliness T5	33%	14	70	29	100	13.5
5	Jobsite rejection of tagged eqp. Q2	33%	16	4	7.9	26.6	0
6	Procurement lead time T1	25%	17	32	48	200	0
7	Bid/evaluate/ commit lead time T2	25%	16	21	25	100	0
8	PO to materials receipt duration	25%	17	23	24	200	0
9	Materials receiving processing T4	33%	14	2	8.9	33.3	0
10	Materials withdrawal request T7	25%	14	24	31	100	0
11	Construction time lost C5	33%	10	6	10	33.3	0
12	Total surplus C11	25%	13	1	1.6	5	0

Similarly, the average value for group B measures were added for the projects and were ranked in descending order of their total score. The higher the score the project had, the higher ranking it achieves. Consequently, the project with the highest score is considered the best.

Since the total weight for group A was found to be 2.24 and the total weight for group B was found to be 1.58, the difference (the adjusting factor) was found to be 0.66.

Table 4 shows the project ranking for group A. Table 5 shows the project ranking for group B.

For the overall ranking, the adjusting factor was used to get a ranking value for the group A. This value with the ranking of group B represent the overall ranking. See table 6. It shows the ranking with some details.

Table 4
Projects ranking for group A

Project No	**Average of group A measures**	**Ranking No.**
11	0	1
9	3.5	2
3	5.8	3
10	7.5	4
5	7.9	5
6	8.04	6
7	9.9	7
2	11.6	8
15	11.9	9
12	12.6	10
13	15.5	11
14	20.4	12
17	21.2	13
8	22.6	14
16	22.8	15
1	29.5	16
4	58.59	17
Average	15.88	
Std. Dev.	13.54	

Table 5
Projects ranking for group B

Project No	Average of group B measures	Ranking No.
3	99.9	1
6	97.1	2
8	95.6	3
9	95	4
10	94	5
14	93	6
13	92	7
11	91	8
1	90.8	9
16	90	10
2	88	11
12	87	12
5	85	13
15	75	14
17	70	15
4	55	16
7	x	
Average	87.79	
Std. Dev.	11.51	

X is a missing value

Table 6
Projects ranking for group B

Project No [1]	**Average A [2]**	**Ranking No. A [3]**	**Adjusting factor [4]**	**Ranking Value A [5]=[4]*[3]**	**Average B [6]**	**Ranking No. B [7]**	**Ranking Value [8]=[5]*[7]**	**Overall Ranking [9]**
3	5.8	3	0.66	1.98	99.9	1	3	1
6	8.04	6	0.66	3.96	97	2	6	2
11	0	1	0.66	0.66	92.7	7	7.7	3
2	11	8	0.66	5.2	95.2	4	9.3	4
14	20	12	0.66	7.9	95.6	3	10.9	5
12	12	10	0.66	6.6	93.6	6	12.6	6
10	7.5	4	0.66	2.6	87.8	12	14.6	7
9	3.5	2	0.66	1.3	75	14	15.3	8
15	11	9	0.66	5.9	90.1	10	15.9	9
4	58	17	0.66	11.2	94	5	16.2	10
5	7.9	5	0.66	3.3	85.8	13	16.3	11
1	29	16	0.66	10.5	91.9	8	18.6	12
16	22	15	0.66	9.9	90.9	9	18.9	13
8	22	14	0.66	9.2	88	11	20.2	14
13	15	11	0.66	7.2	70.8	15	22.3	15
17	21	13	0.66	8.5	55	16	24.6	16
7	9.9	7	0.66	4.6	x			
Average	15.88				87.81			
Std. Dev.	13.54				11.51			

11. CONCLUSION

11.1. Utilization plan for the model

Several steps have to be carefully followed to ensure that the effectiveness of material management process measurements have been correctly carried out;

- Appoint an independent, knowledgeable leader, who with a group of two persons, make up a team to coordinate the study.
- The team should develop a good understanding of the measures and identify the best way to collect the required information.
- The team should be well supported by the management to ensure the cooperation of all involved individuals.
- During the study, the team should explain clearly the meaning of each question in order to receive valid data.
- The team should verify the received data by taking some samples.
- The proposed model could be used by project managers to measure the effectiveness of their materials management in three stages. The reason for measuring project at first stage is to identify the weaknesses of the materials management process and to rectify them before it is too late. Another measurement at the second stage to assess changes made according to the recommendations from the first stage study. The third stage study should give an overall indication about the project management from materials management point of view.

11.2. From the results

- All industrial projects studied were found to have a contract type of lump sum type. A clear indication that it is the preferred type of contract for the industry in Saudi Arabia.

- The study has indicated the existence of a sound and effective materials management process in the industrial projects studied.
- 88% of the projects were found to have from 13 to 48 months duration.
- 71% of the projects had their values ranging between 100 to 200 USD.

12. RECOMMENDATIONS

- Improvement in the area of material management is needed. To achieve that goal, it is required to develop measurement methods.
- Encouraging such studies would lead to a better understanding for the process of material management, and the importance of a measurement method.
- Although, the study of this thesis is valuable, it still need further research and investigation to come up with a method that can be applied for various types of industries and business areas.

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