

IDENTIFICATION OF CONVENIENT INVENTORY MANAGEMENT TECHNIQUES IN CONSTRUCTION OF BUILDINGS

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Abstract— Inventory management is the management of inventory and stock. Inventory management is the administration of the supply and storage and availability of materials in order to insure adequate supply without excessive oversupply, the reason being the minimization of total inventory cost. The inventory takes nearly 60% of the money in a project. Investment in inventory takes up a large amount of working capital of a company and represents a large portion of total assets of a business. Effective inventory management directs and redirects to provide lower cost, the response being rapid and assure flexibility to organization. The investment in inventory constitutes the most significant part of current assets and working capital in most of the undertakings. Thus it becomes essential to have proper control and management of inventory. It is also required that there is a better understanding in inventory management because it ensures availability of materials in sufficient quantity as and when required and also to minimize investment in inventories. The research aim is to suggest the finest inventory technique for the each work packages of construction of buildings. In this research work Just In Time (JIT), ABC, Fast Moving Slow Moving Non Moving (FSN) and Vital Essential Desirable (VED) selective inventory management techniques are applied for inventory in construction of buildings. In this research work three buildings are analyzed by these four techniques of inventory management. Data gives the best suitable technique for particular work packages. In this research work results of each technique of each work packages are very similar for every building.

Keywords— Inventory Management, ABC, JIT, FSN, VED, Building Construction

I. INTRODUCTION

The term Inventory refers to the firm's assets including raw materials and work in progress and finished goods. Inventory constitutes one the most important items of current assets, that permit the smooth operation of production and sale process of the firm, In a way it consist of raw materials, stores, replacements, packing materials, coal, petroleum products, works-in-progress and finished products in stock either at the factory or deposits or construction site. The maintenance of inventory directs to blocking of the funds so that it involves the interest and opportunity cost to the firm. Inventory management is the management of the supply and storage and accessibility of items in order to insure adequate supply without excessive oversupply, the reason being the minimization of total inventory cost.

The purpose of this study is to find out convenient inventory technique for particular work packages of Government office buildings and suggest suitable techniques for inventory control.

II. LITERATURE REVIEW

Hemishkumar Patel et al have done a survey by explorative questionnaire to the respondents involved in daily activities of construction firms in various regions in the Gujarat region of India. This paper represents the analysis of the factors affecting material management and Inventory management ranked in agreement with the most affecting factors based on survey. Base on ranking, most important causes for inventory management by RII were: (1) Misunderstanding of owner's requirements by design engineer.[RII=0.6975]; (2) You pay maximum attention to those inventories whose value is highest.[RII=0.6000]; (3) Goods are inspected on receipt.[RII=0.5975].

Prof. Dipak P. Patil, et al have applied ABC analysis and EOQ to a school building for study cost control on construction project. Research shows that ABC analysis and EOQ which surely will help in reduction of cost on construction site due to a) Wastage control, b) Right incoming quantity, c) Materials handling, d) Strict control, e) Frequent ordering, f) Accurate forecast.

According to A K Madan and Ranganath M. S combining of all techniques like Just In Time, ABC analysis and VED analysis are found very effective and efficient. By this results were very helpful to industry. This study has enabled the managers to design an appropriate inventory management or inventory modelling system which would keep track of the entire inventory and hence help in reducing them.

Carlos H. Caldas et al describes a study in which the purpose was to identify materials management techniques that reflect current and emerging practices in the capital projects industry. Surveys, interviews, and case studies involving 54 organizations were used to achieve this purpose. The authors have drawn a number of conclusions from the information gathered. First, materials management is expanding its role in the early phases of capital project planning. Global procurement is well established but complex.

T. Phani Madhavi et al. have carried out thorough study along with study of cases, surveys and interviews to professionals involved in this area and Authors find a great potential for improvement was detected if state of the art technologies such as, electronic mail, electronic data interchange (EDI), and analysis were applied to the procurement process. These helped to eliminate the root causes for many types of problems that were detected.

Pramod Kumar and Mohd. Anas considered a study as qualitative single-case study and the study method employed includes ABC analysis for the stocking arrangements. Observation of the production process was done to see the flow of goods in the conversion process. These recommendations are considered, the company's inventory management situation will rise a lot. 1) Review of stock-levels, 2) Cycle counting 3) Identifying items for potential consignment. Analysis shows that company follows the ABC analysis for multiple- products. It was observed that there is no relation between annual demand and total costs of the products.

III. METHODOLOGY

A. Four techniques are used in this research work

1) *ABC analysis*: In this technique there is classification on the basis of sale and the cost of production so it helps in construction of building to categorized item on the basis of consumption. Under this method, classify the inventory into three categories, such as A, B and C. These categories are based upon the inventory value and cost impact. Also, the number of items and values of each category are expressed as a percentage of the total

- Items of great value and small in number are termed as “A”
- Items of reasonable value and moderate in number are termed as “B”
- Items of small in value and huge in number are termed as “C”

2) *VED analysis*: In this technique there is also categorized items but there is some different in category on the basis of vital, essential, and desirable. This technique is useful in construction industries because there are lot of material which had to tackle on site.

- Vital (V): Vital category items are those items without which the production activities or any other activity of the company, would come to a halt, or at least be drastically affected.
- Essential (E): A spare part will be considered essential if, due to its non-availability, modest loss is incurred.
- Desirable (D): A spare part will be desirable if the production loss is not vary significant due to its non-availability. Most of the parts will fall under this category The VED analysis helps in focusing the attention of the management on vital items and ensuring their availability by frequent review and reporting.

3) *FSN analysis*: This techniques is mainly depend upon the how item is movable on any project so the construction industries had so many items which are movable so we can manage the item easily in construction site. This analysis is to help control obsolescence and is based on the consumption pattern of the items. The items are analyzed to be classified as Fast-moving (F), Slow-moving and Non-moving (N) items. The Non-moving items are of great importance. Scrutiny of non-moving items is to be made to determine whether they could be used or be disposed off. The fast and slow-moving classifications help in arrangement of stock in stores and their distribution and handling methods.

4) *Just in time*: This technique is very effective to get items in very short time. Just in time does what the name recommends; it involves having products arrive as soon as the customer orders them. JIT applications on continuous improvement and can improve a manufacturing organization's return on investment, quality, and efficiency.

B. Work packages of buildings

Work packages are divided into 4 parts:

- 1) *Sub structure*: Excavation, P.C.C., Footing, Back Filling, Column up to plinth level, Ground beam, Plinth beam, Grade slab, Masonry, Plaster.
- 2) *Super structure*: Column up to terrace level, Beams & slabs at all floor level, Lift, pardi & staircases, Lintels, copping, chajjas & loft, Masonry up to terrace level, Inside and outside plastering, Flooring, Door & Window fitting, White washing at each floor, Paint.

IV. ANALYSIS

A. Material calculation of all projects in sub structure package

Table-1 Quantity of Each Material in Sub Structure

MATERIALS	BUILDING 1	BUILDING 2	BUILDING 3
Cement (Nos. Of bags)	5803	4239.84	3678.38
Sand (ton)	680.93	513.23	444.89
20 mm Coarse Aggregates (ton)	885.84	631.94	554.75
10 mm Coarse Aggregates (ton)	344.54	245.7916	215.76
Steel (kgs.)	59514	42197	53012.40
Bricks nos.	35500	28250	18500
Lime (m ³)	28.5	21	16.6

B. Material calculation of all projects in super structure package

Table-2 Quantity of Each Material in Super Structure

MATERIALS	UNITS	BUILDING 1	BUILDING 2	BUILDING 3
Steel	Kg	180790	104942	112449
Cement	Bags	8525.5	7366.602	6490.82
Coarse aggregate (20 mm)	Ton	1085.15	856.125	709.55
Coarse aggregate (10 mm)	Ton	422.06	332.98	275.97
Sand	Ton	1215.61	1161.3	1047.5
Kota stone	M2	512	486.5	1356.6
Vitrified tiles	No.	95050	83050	70233
Aluminum window	M2	294.5	207.5	156.45
Granite slab	M2	327	221	550.83
China mosaic flooring	M2	833	0	0
Emulsion plastic paint	Lit	694	571	583
Flush door shutter	M2	108	87	109
Concrete block	M2	1506	421	0
Ceramic tiles	M2	651	289	420
M.s. grills	Kg	1800	5172.5	7695.45
Acrylic lappy (putty)	M2	7642	7451.5	5772.9
Brick	No.	194500	197500	265000

C. Analysis of sub structure building 1

1) ABC analysis:

Table-3 Identify rank for materials used in building 1 sub structure

MATERIAL	QUANTITY	RATE Rs/unit	AMOUNT (Rs)	% TO TOTAL AMOUNT	RANK
Cement (Bags)	5803.00	280	1624840.00	24.02	2
Steel (kg)	59514.00	48	2856672.00	42.22	1
Sand (ton)	680.93	750	510698.78	7.55	5
Coarse Aggregate (20 mm) (ton)	885.85	800	708676.72	10.47	3
Coarse Aggregate (10 mm) (ton)	344.55	600	206727.60	3.06	6
Brick (nos)	35500.00	4.5	159750.00	2.36	7
Lime (m3)	28.50	24500	698250.00	10.32	4
		TOTAL	6765615.095	100	

Table-4 Identify class for materials used in building 1 sub structure

MATERIAL	RANK	% TO TOTAL AMOUNT	CUMULATIVE PERCENTAGE (%)	CLASS
Steel	1	42.22	42.22	A
Cement	2	24.02	66.24	A
Coarse Aggregate (20 mm)	3	10.47	76.71	B
Lime	4	10.32	87.03	B
Sand	5	7.55	94.58	C
Coarse Aggregate (10 mm)	6	3.06	97.64	C
Brick	7	2.36	100.00	C

Table-5 Provide scaling for each categories for ABC analysis of building 1 sub structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
A	2	70	50%
B	2	20	30%
C	3	10	20%
TOTAL	7	100	100%

2) VED analysis:

Table-6 Materials identification for VED analysis of building 1 sub structure

V (VITAL)	E (ESSENTIAL)	D (DESIRABLE)
Cement	Sand	Lime
Steel	Coarse aggregate 20 mm	Brick
	Coarse aggregate 10 mm	

Table-7 Provide scaling for each categories in VED analysis of building 1 sub structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
V	2	28.57	50%
E	3	42.85	30%
D	2	28.57	20%
TOTAL	7	100	100%

3) FSN analysis:

Table-8 Materials identification for FSN analysis of building 1 sub structure

F (FAST MOVING)	S (SLOW MOVING)	N (NON MOVING)
Cement	Lime	-
Steel	Brick	-
Sand	-	-
Coarse Aggregate 20 mm	-	-
Coarse Aggregate 10 mm	-	-

Table-9 Provide scaling for each categories in FSN analysis of building 1 sub structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
F	5	71.42	50%
S	2	28.58	30%
N	0	0	20%
TOTAL	7	100	100%

4) Just in time: In this method there is no material which lies under this technique so this technique is not applicable in the sub structure.

5) Result of sub structure building 1:

Table-10 Result of all analysis of building 1 sub structure

BUILDING 1	50%	30%	20%	WEIGHTED SCORING
ABC	2	2	3	2.2
VED	2	3	2	2.3
FSN	5	2	0	3.1
JIT	0	0	0	0

D. Analysis of Super structure building 1

1) ABC analysis:

Table-11 Identify rank for materials used in building 1 super structure

MATERIAL	UNIT	QUANTITY	RATE RS/UNIT	AMOUNT (RS)	% TO TOTAL AMOUNT	RANK
Steel	Kg	104942	48	5037216	23.63	1
Cement	Bags	7366.602	280	2062648.56	9.68	4
Coarse Aggregate (20 mm)	Ton	1085.15	800	868120	4.07	8
Coarse Aggregate (10 mm)	Ton	422.06	600	253236	1.19	13
Sand	Ton	1215.61	750	911707.5	4.28	6
Kota stone	M2	512	430	220160	1.03	14
Vitrified tiles	No.	95050	32	3041600	14.27	3
Aluminum window	M2	294.5	2700	795150	3.73	9
Granite slab	M2	327	1450	474150	2.22	11
China mosaic flooring	M2	833	1615	1345295	6.31	5
Paint	Lit	694	300	208200	0.98	15
Flush door shutter	M2	108	4800	518400	2.43	10
Concrete block	M2	1506	2700	4066200	19.07	2
Ceramic tiles	M2	651	200	130200	0.61	16
M.S. grills	Kg	1800	70	126000	0.59	17
Acrylic lappy (putty)	Kg	5481.86	70	383730.2	1.80	12
Brick	No.	194500	4.5	875250	4.11	7
				21317263.26	100.00	

Table-12 Identify class for materials used in building 1 super structure

MATERIAL	RANK	% TO TOTAL AMOUNT	CUMULATIVE PERCENTAGE (%)	CLASS
Steel	1	23.63	23.63	A
concrete block	2	19.07	42.70	A
Vitrified tiles	3	14.27	56.97	A
Cement	4	9.68	66.65	A
china mosaic flooring	5	6.31	72.96	B
Sand	6	4.28	77.24	B
Brick	7	4.11	81.34	B
Coarse Aggregate (20 mm)	8	4.07	85.41	B
Aluminum window	9	3.73	89.14	B
Flush door shutter	10	2.43	91.58	C
Granite slab	11	2.22	93.80	C

acrylic lappy (putty)	12	1.80	95.60	C
Coarse Aggregate (10 mm)	13	1.19	96.79	C
Kota stone	14	1.03	97.82	C
paint	15	0.98	98.80	C
Ceramic tiles	16	0.61	99.41	C
M.S. grills	17	0.59	100.00	C

Table-13 Provide scaling for each categories for ABC analysis of building 1 super structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
A	4	70	50%
B	5	20	30%
C	8	10	20%
TOTAL	17	100	

2) VED analysis:

Table-14 Materials identification for VED analysis of building 1 super structure

V (VITAL)	E (ESSENTIAL)	D (DESIRABLE)
Steel	Vitrified tiles	M.S. grills
Cement	Concrete block	Acrylic lappy (putty)
	Coarse Aggregate (20 mm)	Kota stone
	Coarse Aggregate (10 mm)	Aluminum window
	Sand	Brick
	Flush door shutter	Ceramic tiles
		Granite slab
		Paint
		China mosaic flooring

Table-15 Provide scaling for each categories in VED analysis of building 1 super structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
V	2	11.76	50%
E	6	35.29	30%
D	9	52.94	20%
TOTAL	17	100.00	100%

3) FSN analysis:

Table-16 Materials identification for FSN analysis of building 1 super structure

F (FAST MOVING)	S (SLOW MOVING)	N (NON MOVING)
Steel	Coarse Aggregate (20 mm)	M.S. grills
Cement	Coarse Aggregate (10 mm)	Granite slab
	Sand	Paint
	Brick	China mosaic flooring
	Ceramic tiles	M.S. grills
		Acrylic lappy (putty)
		Kota stone
		Aluminum window
		Flush door shutter
		Concrete block

Table-17 Provide scaling for each categories in FSN analysis of building 1 super structure

CATEGORIZED	NO. OF ITEM	PERCENTAGE INVOLVEMENT (%)	SCALING
F	2	11.76	50%
S	5	29.41	30%
N	10	58.82	20%
	17	100.00	100%

4) Just in time: In this method there is no material which lies under this technique so this technique is not applicable in the super structure.

5) Result of super structure building 1:

Table-18 Result of all analysis of building 1 super structure

BUILDING 1	50%	30%	20%	WEIGHTED SCORING
ABC	4	5	8	5.1
VED	2	6	9	4.6
FSN	2	5	10	4.5
JIT	0	0	0	0

E. Analysis of sub structure building 2

1) Result of sub structure building 2:

Table-19 Result of all analysis of building 2 sub structure

BUILDING 2	50%	30%	20%	WEIGHTED SCORING
ABC	2	2	3	2.2
VED	2	3	2	2.3
FSN	5	2	0	3.1
JIT	0	0	0	0

F. Analysis of super structure building 2

1) Result of super structure building 2:

Table-20 Result of all analysis of building 2 super structure

BUILDING 2	50%	30%	20%	WEIGHTED SCORING
ABC	4	5	8	5.1
VED	2	7	8	4.7
FSN	2	8	7	4.8
JIT	0	0	0	0

G. Analysis of sub structure building 3

1) Result of sub structure building 3:

Table-21 Result of all analysis of building 3 sub structure

BUILDING 3	50%	30%	20%	WEIGHTED SCORING
ABC	2	2	3	2.2
VED	2	3	2	2.3
FSN	5	2	0	3.1
JIT	0	0	0	0

H. Analysis of super structure building 3

1) Result of super structure building 3:

Table-22 Result of all analysis of building 3 super structure

BUILDING 3	50%	30%	20%	WEIGHTED SCORING
ABC	4	5	8	5.1
VED	2	6	9	4.6
FSN	2	5	10	4.5
JIT	0	0	0	0.0

V. CONCLUSION

For organized construction projects it is observed to apply the same inventory technique for all work packages of construction activity could not reflect effective productivity, so it is advisable to analyze the construction activities at various phases and suggesting the most feasible techniques in this regard. The effects are made here for the construction of office building to suggest applicable techniques of inventory management at various work packages.

The outcome of obtained /suggested inventory management techniques at various work packages of construction of office buildings are reported in above. However the summarized outcome of suggestive technique at each package can be represented as in table 23.

With the context of suitability of application of inventory techniques at sub structure and super structure phases of construction of office buildings following result is obtained.

Table-23 Result of all phases of all analytical buildings

WORK PACKAGE	SUB STRUCTURE	SUPER STRUCTURE
BUILDING 1	FSN	ABC
BUILDING 2	FSN	ABC
BUILDING 3	FSN	ABC

In this research work three buildings are analyzed by all above mentioned inventory management techniques. There are main two work packages of all above mentioned buildings. In this research work this all techniques are studied well and then apply on each work packages of each building so that we could get proper outcome. In this research work the main aim is that to suggest best suitable technique for each work packages of all building which is shown in above table-23.

In this research work all work packages had their own technique from that we can suggest the best suitable technique for each building. From the above obtained analysis FSN is finest for sub structure and ABC is finest for super structure.

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