

Analysis of Inventory Management on cost project overrun post COVID 19 in Amravati district

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Abstract- Construction Industry involves multi echelon supply chain. With so many stake holders involved, the inventory management becomes a critical aspect of construction project management. Construction industry faces a lot of problem due to poor inventory management, these projects over run the time and the allocated budget. The concept of inventory management system has been one of analytical aspects of management establishing control over purchase, storing and to keep track of the materials, workforce, equipment and production units involved for construction projects. The proper management of this component can improve the productivity and cost efficiency of a project. One of the major problems in delaying construction projects is poor managing systems. The inventory management system for construction industry involves procurement, identification, transport and storage of materials in construction projects. The main objective of our study is to investigate the efficiency and its impact in application of inventory management system in construction of small scale projects. Identification of impacts and risk influences of inventory management systems in a small-scale project. The lack of proper handling and storage of material in construction site has made it difficult to track and locate the material availability and suggestion about inventory management system and its control over efficiency construction projects will be analyzed and the outcome of the effective utilization of inventory at construction site of small scale project to overcome the difficulties by giving best the possible recommendations. ABC analysis is one of the most conventionally inventory management system suited for construction infrastructure. The study will focus on the importance and economic benefit of inventory management for construction practitioners.

Keywords- Inventory, resource, construction, materials, management.

I. PROBLEM STATEMENT

Many ongoing construction sites are facing various problems to keep up the regular supply of materials used in construction, Though most of the materials are easily available, few are scarce or difficult to procure due to various

reasons such as; inflation, non- availability of material, Seasonal Supply, etc. This creates a problem of either halting the construction activity which delays the completion of project work or compromises the quality of work. Moreover if the materials are procured in excess quantity the price of their inventory increases the entire price of the project. As Kini (1999) pointed out that 50~60% of the total construction cost goes to materials and equipment. Some construction Project may experience project cost for material ranged from 30 to 80% of the total construction cost (Proverb, et al., 1999) It is therefore vital to control this large portion of tangible cost, and every penny save will contribute to the profitability of the project. Inventory Control and waste Control on site remains a low priority for the majority of the contractors (Begum, 2009). When construction site is less concerned on inventory control more materials and labour times are wasted. An estimated about 10 to 30 per cent of wastes disposed of for landfills originate from construction site (Fishbein, 1998). This research is to give awareness for builders to look seriously on inventory control where saving of materials and labour times can impact the profitability of the project.

II. RESTATEMENT OF RESEARCH OBJECTIVES

The main objective of this study was to study the role of inventory management in construction industry and analyzing the possibility of applying inventory management system in construction sectors and determine the inventory-management practices of Construction firms at Amravati, Maharashtra. To achieve this objective, the following sub-objectives were pursued:

- To determine the inventory-management practices of various construction firms at Amravati, Maharashtra.
- To evaluate the effectiveness of the inventory-management practices used by them;
- To determine the challenges, if any, that is experienced by the construction firms from the inventory-management practice currently used.

III. RESPONSE RATE

The targeted population of this study comprised 3

construction companies from Amravati, Maharashtra, India. Amravati is up-coming one of the newest smart cities in Maharashtra. The top builders and developers have gifted excellent unique designed residential and commercial properties to Amravati. For the aim of this study, primary data is collected and used within the analysis to make conclusions. This primary data was collected by questionnaire survey forms that were distributed to the targeted respondents. In total, 30 responses were obtained throughout field survey at the 3 building construction projects severally between 12.00pm and 3.00pm. The questionnaire survey was conducted throughout the lunch hour to accommodate the users who won't be free throughout operative times. A target sample of 30 responses was set. To achieve this target, 35 questionnaires were hand-distributed to three construction firms located in different suburbs of the Amravati city. Of the questionnaires distributed, 30 usable questionnaires were returned as 5 targeted respondents declined to participate in the study. This yielded a response rate of 85.70%, as summarized in Table 1. The response of this study was thus higher than that of a comparable study (Ngubane et al., 2015) whose response rate was 42%. It also follows Fowler's (1988) recommendation that a response rate should be above 20% to provide credible statistics about a population.

Table 1: Response Rate (Source: Own source)

Description	Number of Respondents	Percentage
Questionnaire distributed	35	100 %
Questionnaire not returned	5	14.30 %
Number of questionnaire obtained	30	85.70

IV. PROJECT CHARACTERISTICS

Section B of the questionnaire was aimed at investigating the ongoing Project characteristics. This section comprised 5 questions, namely type of work, the complexity of the project, contract price, proposed project duration and the lastly the respondents were asked whether the purchased order transaction are completely prepared and recorded on a timely basis or not. Following Fig. 5 shows the responses from each of the 3 construction companies:

Table 2: Section-B: Project Characteristics (Response)

Sr. No.	Details	Company-A	Company-B	Company-C				
1	Type of work (please tick all applicable options)							
	Infrastructure works	✓	✓	✓				
	Ground works	✓		✓				
	Earthworks	✓	✓	✓				
	Foundation works		✓					
	Concrete works	✓		✓				
	Laying of trucks		✓					
	Steel & welding works	✓		✓				
	False works			✓				
	Demolishing works		✓					
Utility Diversion works	✓		✓					
Others (Please Specify)								
2	How would you rate the complexity of this project? Very Simple.....Complex	4	3	4				
	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> </table>	1	2	3	4	5		
1	2	3	4	5				
3	What is the contract price?	90 Lakhs	1 Crore	1.2 Crore				
4	What is the proposed project duration?	2 Years	2.5 Years	2 years 9 months				
5	All purchase order transactions are completely prepared and recorded on a timely basis?	Yes	No	Yes				

V. COST VARIANCE FOR CEMENT, STEEL & BRICK

An ongoing project of the residential apartment with the Stilt+4 floors was taken for the case study for the research work. The residential apartment has the built-up area of 3224.20 square feet with three dwellings per floor.

1. S-Curve Analysis: The S-curve is stated as “a display of cumulative costs, labour hours or other quantities plotted against time or other parameters”. It is a form of numerical theory, which represent the usage of materials over the stipulated time of the project. The curve explains the comparison of the actual time and expenditure components vs. the estimated costs and time allotted for specific resources. It is used to track the growth in the project. In this research we use S-Curve to analyse the comparison of the planned material's cost and the actual material's cost. The S-curve analysis is carried out for some of the most important construction materials such as Cement, Steel and Bricks. The similarity between planned and actual material cost of Cement, Steel and Brick in the construction of a residential apartment is shown in Table 3, Table 4, and Table 5 respectively. It is very clear from the graphs that the actual materials cost is higher than the planned materials cost. The Cost Performance Index is less than 1 for all the 3 materials states that there is a cost teeming in the project. Though this is a small apartment project, the materials management aspect is same for small and big projects.

Table 3: Cost Performance for Cement

Sr. No.	Floor	Planned cost (INR)	Actual cost (INR)	Cost variance (INR)	Cost Performance Index
1	Stilt	425655	468220	42565	0.909
2	First	359640	397403	37763	0.905
3	Second	359640	396324	36684	0.907
4	Third	359640	397523	37943	0.905
5	Fourth	359640	397762	38122	0.904

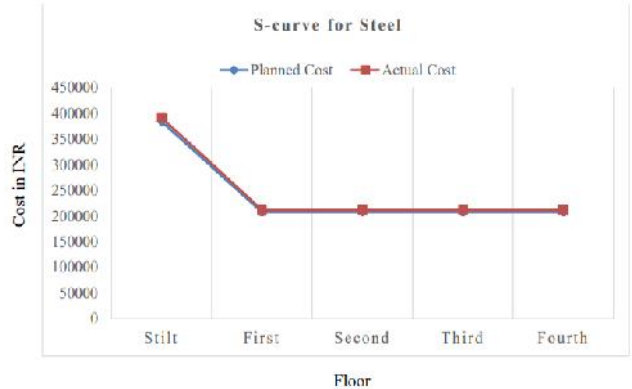


Fig. 2 Cost Performance for Steel

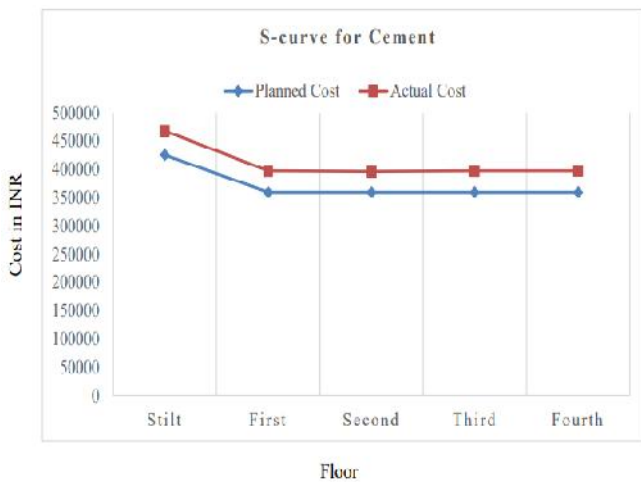


Fig. 1 Cost Performance for Cement

Table 4: Cost Performance for Steel

Sr. No.	Floor	Planned cost (INR)	Actual cost (INR)	Cost variance (INR)	Cost Performance Index
1	Stilt	384230	391914	7684	0.980
2	First	207477	211420	3943	0.981
3	Second	207477	211523	4046	0.981
4	Third	207477	211502	4025	0.981
5	Fourth	207477	211586	4109	0.980

Table 5 Cost Performance for Brick

Sr. No.	Floor	Planned cost (INR)	Actual cost (INR)	Cost variance (INR)	Cost Performance Index
1	Stilt	47888	54592	6704	0.877
2	First	270142	302560	32418	0.893
3	Second	270142	304720	34578	0.887
4	Third	270142	304990	34848	0.885
5	Fourth	270142	305260	35118	0.885



Fig. 3 Cost Performance for Brick

V. RESPONDENTS PROFILE

Section-D of the questionnaire asked respondents to provide their personal profile As far as their personal profile is concerned, the respondents were asked to provide information on the position held in the organization, their highest level of qualification, and if the qualification was accounting-related. These questions were deemed necessary to ensure that only the intended respondents participated in the study and that those participating were knowledgeable about the inventory-management practices of their entities. The 30 useable questionnaires obtained from construction organizations. Figures below illustrate the number and percentage of the respondents for each section according to their designation, department, work experience, educational qualification and gender; also for quality management overview.

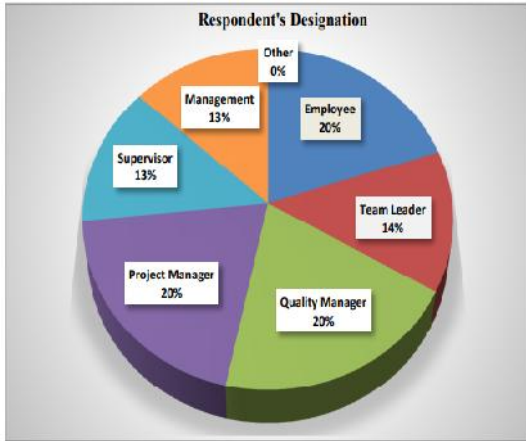


Fig. 4 Respondent's Profile: Designation

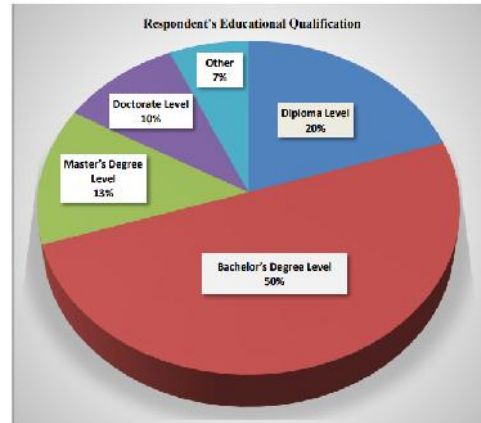


Fig. 7 Respondent's Profile: Educational Qualifications

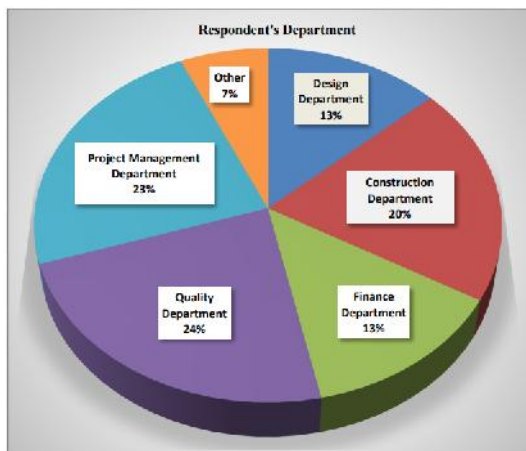


Fig. 5 Respondent's Profile: Department

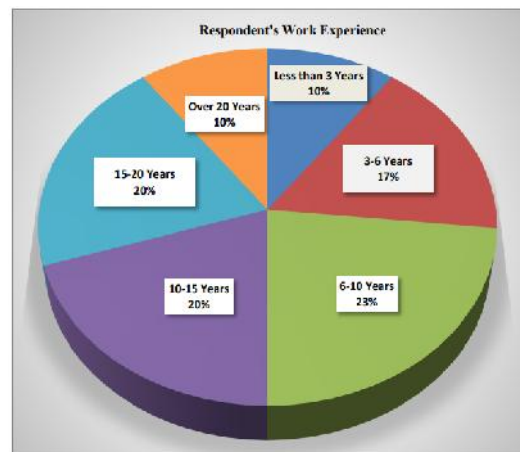


Fig. 6 Respondent's Profile: Work Experience

VI. INVENTORY MANAGEMENT OVERVIEW

Construction inventory management is a means by which construction companies and suppliers can keep track of materials, workforce, equipment and plant. This is particularly important when a construction company has multiple projects to manage, as efficient scheduling can become very complicated. A well-managed inventory can be critical to profitability as delayed, misplaced or lost items can incur avoidable delays and unnecessary costs.

Section-E of the questionnaire helps to identify the respondents' thoughts on inventory management. There were total 15 statements given to the respondents on which they have to show their response on the basis of 5 five Likert's scale ranging from 1 to 5 (strongly disagree to strongly agree). Following Table 6 shows the responses obtained and on the basis of that weighted mean and relative weight to each statement was found out.

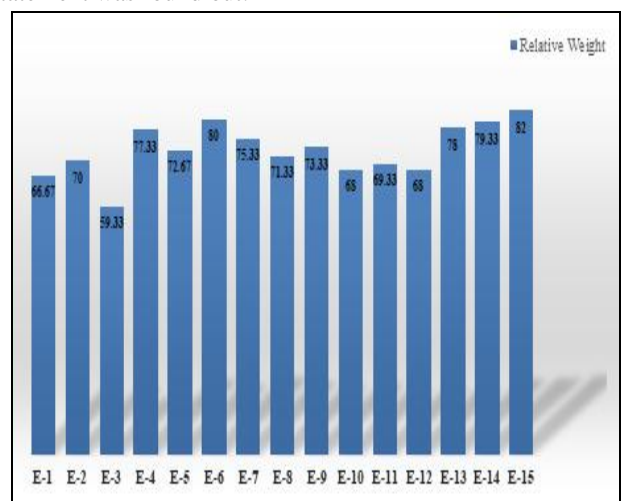


Fig. 8 Bar Chart showing Relative Weight of the Inventory Management Statements

Table 6 Section-E: Inventory Management Overview Responses

ID	Statements	Responses					Variance	Weighted Mean	Relative Weight (%)
		1	2	3	4	5			
E-1	Inventory management helps to reduce construction material wastage.	4	4	4	14	4	20	3.33	66.67
E-2	Inventory management tools & model improve material ordering time.	4	4	5	7	10	6.5	3.50	70.00
E-3	Inventory management tools & model control the flow of material and machinery.	6	6	6	7	5	0.5	2.97	59.33
E-4	Less wastage mean increase profitability.	2	3	5	7	13	19	3.87	77.33
E-5	Computerized Inventory management software allows more flexibility and efficient on materials tracking and control.	1	6	6	7	10	10.5	3.63	72.67
E-6	Inventory control is to keep track of stock and knowing what materials are being stocked and how much of that particular item is available.	2	3	4	5	16	32.5	4.00	80.00
E-7	Tracking on materials and equipment at site make easy by using inventory management system.	1	5	5	8	11	14	3.77	75.33
E-8	Inventory management can help to locate material plants & equipments in accordance to work schedule.	4	3	5	8	10	8.5	3.57	71.33
E-9	Work schedule and inventory management can be synchronized.	4	3	3	9	11	14	3.67	73.33
E-10	Plant and equipment will be at working condition when properly upkeep.	5	4	4	8	9	5.5	3.40	68.00
E-11	Inventory management can organized stocks & materials inventory efficiency	4	4	5	8	9	5.5	3.47	69.33
E-12	Reduce excessive ordering of building materials, plant and equipment.	5	5	2	9	9	9	3.40	68.00
E-13	Inventory management using QR code (Quick Response Code) for efficient product tracking, item identification, time tracking and document management.	2	2	4	11	11	21.5	3.90	78.00
E-14	Inventory management improve man power allocation	2	2	2	13	11	30.5	3.97	79.33
E-15	Labourer and craftsman are able to work effectively and no time wasted on searching for materials.	1	2	3	11	13	31	4.10	82.00

As summarized in Figure 8, most respondents, 82% agreed upon the statement that if there is proper inventory management at site then the labourer and craftsman are able to work effectively and no time wasted on searching for

materials, while 80% respondents agreed that inventory control is to keep track of stock and knowing what materials are being stocked and how much of that particular item is available.

Of the respondents, 79.33% indicated that inventory management improve man power allocation. Manpower Allocation consists of putting right number of people, right kind of people at the right place, right time, doing the right things for which they are suited for the achievement of goals of the organization, while 78 % indicated that Inventory management using QR code (Quick Response Code) for efficient product tracking, item identification, time tracking and document management would be very beneficial for the construction organizations. Less wastage mean increase profitability, this statement is agreed by almost 77.33% respondents.

Likewise tracking on materials and equipment at site make easy by using inventory management system agreed by 75.33% respondents. Followed by computerized inventory management software allows more flexibility and efficient on materials tracking and control (72.67%). Inventory management tools & model improve material ordering time agreed by 70%. Then 69.33% respondents agreed on the fact that inventory management can organized stocks & materials inventory efficiency. Plant and equipment will be at working condition when properly upkeep and reducing excessive ordering of building materials, plant and equipment, both the statements agreed by 68% respondents. Inventory management helps to reduce construction material wastage agreed by 66.67%. Inventory management tools & model control the flow of material and machinery agreed by 59.33% respondents.

As it can be seen that the respondents agreed percentage for all the statement is more that 50%. It clearly shows that all the statements were reliable and construction personals find it significant with the view of inventory management.

VII. ORGANIZATION PERFORMANCE DUE TO PROPER INVENTORY MANAGEMENT

Inventory managers are concerned with cost, criticality and contribution of their holdings. Ordering and maintaining inventory has several costs. These include capital costs, administrative expenses, storage charges, shrinkage, taxes and insurance. Most of these vary directly with the average quantity of inventory held. An obvious strategy for cost avoidance would be to reduce or eliminate inventories.

The company recognizes that customer satisfaction in a

manner that the Inventory control managers defines how often inventory levels are reviewed to determine when and how much to order. It is performed on either a perpetual or a periodic basis. Inventory manager’s implements inventory policy, they use customer demand to pull product through the distribution channel and an alternative philosophy used in the organization which allocates inventory on the basis of forecasted demand of product availability. This section therefore sought to find out the effects of inventory management system on organizational performance.

Section F of the questionnaire helped to identify the factors responsible for good organizational performance due to proper inventory management. This section includes various statements under the following head namely inventory control, inventory speed, inventory cost and inventory accountability. Means are used to calculate measures of central tendencies in order to determine the typical average value in the distribution. The mean is preferred as it takes into account the precise score of each case thus it incorporates more information than the median which only states a scores relative position. A 5 point likert scale was used to measure the study variables with 5 score for strongly agree and 1 for strongly disagree. The standard deviation on the other hand, was used to measure variation but would elicit a negative or positive signs to show the direction of variation.

Following Table 7 to Table 10 shows the responses obtained and on the basis of that weighted mean and standard deviation of each statement was found out.

Table 7 Section-F: Organization Performance due to Proper Inventory Management (Inventory Control Statements Responses)

Sr. No.	I. D.	Variables	Responses					Weighted Mean	N	Weighted Std. Deviation
			1	2	3	4	5			
Inventory Control										
1	F-1	Effect of procurement of materials enhances productivity	4	3	5	7	11	3.60	5	3.71
2	F-2	Storage of materials ensures continuity of production and productivity	3	5	4	8	10	3.57	5	3.56
3	F-3	Meeting customer expectation produces customer satisfaction	4	3	5	7	11	3.60	5	3.71
4	F-4	customer repeating purchase for a particular means that such customer is satisfy	4	4	3	9	10	3.57	5	3.78
5	F-5	Knowing stock at hand and expected stock enhance firms growth	2	2	3	11	12	3.97	5	4.95
6	F-6	Growth of a firm is measured based on the level stock it has	4	6	7	5	8	3.23	5	3.11

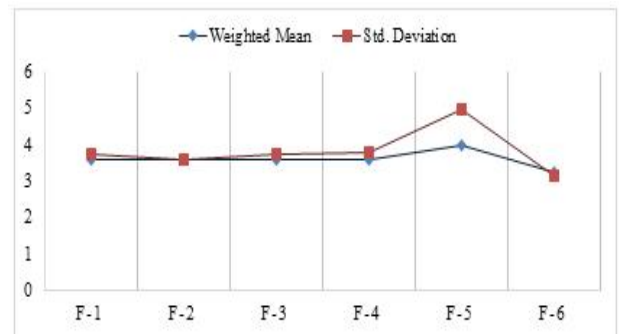


Fig. 9 Chart showing Standard Deviation for Inventory Control Statements

Table 8 Section-F: Organization Performance due to Proper Inventory Management (Inventory Speed Statements Responses)

Sr. No.	I. D.	Variables	Responses					Weighted Mean	N	Weighted Std. Deviation
			1	2	3	4	5			
Inventory Speed										
7	F-7	The rate of inventory turnover in your organization is high	3	2	2	11	12	3.90	5	4.98
8	F-8	Incoming inventories at your organization are calculated to the most economical levels	4	4	4	9	9	3.50	5	3.5
9	F-9	Strategies are employed to vary inventory speed	4	4	3	9	10	3.57	5	3.78
10	F-10	Strategies employed to vary inventory speed are very efficient	3	3	4	10	10	3.70	5	4.01

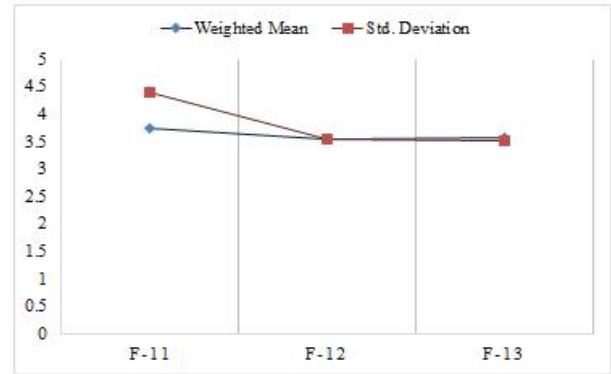


Fig. 9 Chart showing Standard Deviation for Inventory Cost Statements

Table 10 Section-F: Organization Performance due to Proper Inventory Management (Inventory Accountability Statements Responses)

Sr. No.	I. D.	Variables	Responses					Weighted Mean	N	Weighted Std. Deviation
			1	2	3	4	5			
Inventory Accountability										
14	F-14	There is document verification in receiving and issuing of inventory in your organization	2	2	3	11	12	3.97	5	4.95
15	F-15	Declaration of inventory is done effectively	2	4	3	10	11	3.80	5	4.34
16	F-16	Verification of documents are filed well for future reference	3	4	5	8	10	3.60	5	3.54
17	F-17	Counter checking is done at entry and exit of your organization	4	4	4	8	10	3.53	5	3.54

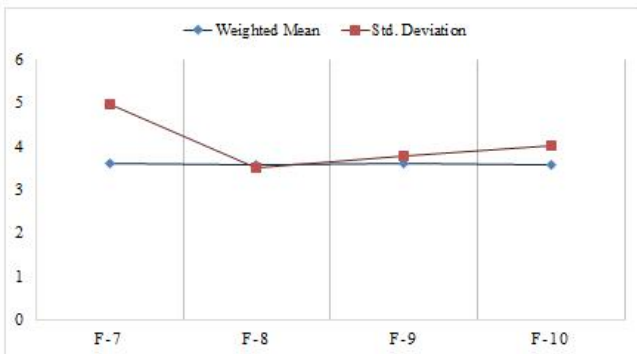


Fig. 10 Chart showing Standard Deviation for Inventory Speed Statements

Table 9 Section-F: Organization Performance due to Proper Inventory Management (Inventory Cost Statements Responses)

Sr. No.	I. D.	Variables	Responses					Weighted Mean	N	Weighted Std. Deviation
			1	2	3	4	5			
Inventory Cost										
11	F-11	Inventory running cost is relatively low in your organization	3	4	2	10	11	3.73	5	4.38
12	F-12	There are strategies set in your organization to ensure low inventory running cost	4	4	4	8	10	3.53	5	3.54
13	F-13	The strategies set are effective and efficient in cutting cost of running inventory management	3	4	5	9	9	3.57	5	3.51

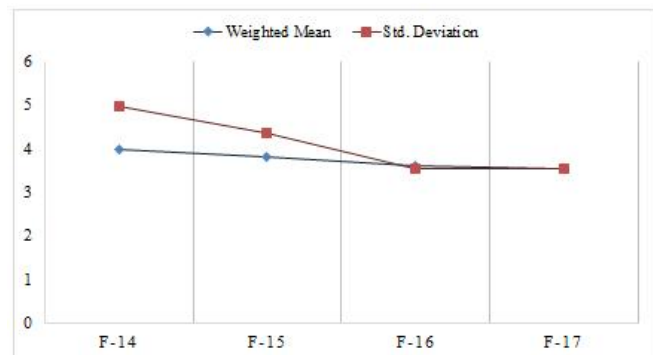


Fig. 11 Chart showing Standard Deviation for Inventory Accountability Statements

The study sought to find out from respondents if inventory control influenced organization performance. Six questions as to whether their construction firm had stringent inventory control measures; the methods were relevant to the

type of inventory held, they had an inventory control manager who knew what he was doing, inventory control was being managed strategically. As can be seen from the Table 7, the mean for the six questions on inventory control are 3.60, 3.57, 3.60, 3.57, 3.97 & 3.23 respectively. The average mean for inventory control was thus 3.59. Also the standard deviation of statement F-5 i.e. 'knowing stock at hand and expected stock enhance firms growth', only somewhat deviate from its mean scores, while all other variables indicated minimum deviation between their standard deviation & mean values. This indicate that majority of the respondents agreed that inventory control influenced organizational performance. Then it was expected to find out from respondents if inventory speed influenced their organizational performance. Specifically the study sought to establish whether rate of inventory turnover was high, incoming inventory was calculated to the most economical levels, strategies were employed to vary the speed of inventory, strategies employed to monitor inventory speed were excellent. The means 3.90, 3.50, 3.57 & 3.70 respectively. The average for the four being 3.67. Then as can be seen from Figure 9, standard deviation of statement F-1 i.e. 'The rate of inventory turnover in your organization is high', somewhat deviate from its mean scores, while all other variables indicated minimum deviation between their standard deviation & mean values. This indicates that most respondents agreed that inventory speed influenced the performance of their organization. The findings are presented in Table 8. Next was to find out from respondents if inventory cost influenced organizational performance. From the findings in Table 9 above, inventory running cost are relatively low, strategies are set to ensure low inventory running cost, strategies set are relevant to the then inventory and the strategies set are efficient in cost cutting. The mean for the three statements were 3.73, 3.53 & 3.57 respectively. Average Mean for inventory cost is found to be 3.61. Then as can be seen from Figure 9, standard deviation of statement F-11 i.e. 'Inventory running cost is relatively low in your organization', somewhat deviate from its mean scores, while all other variables indicated minimum deviation between their standard deviation & mean values. This indicates that most respondents agreed that inventory cost influenced the performance of their organization.

Lastly respondents were asked whether inventory accountability influenced organizational performance. Specifically they were to answer as to whether there were verification documents in receiving and issuing of inventory, declaration of inventory was done effectively, verification documents were filled well for future reference and counter checking was done at entry and exits of their construction organization by security. The mean for the four statements were 3.97, 3.80, 3.60 & 3.53 respectively. Average Mean for

inventory accountability is found to be 3.73. Then as can be seen from Figure 10, standard deviation of statement F-14&F-15 i.e. 'There is document verification in receiving and issuing of inventory in your organization' and 'Declaration of inventory is done effectively', somewhat deviate from its mean scores, while all other variables indicated minimum deviation between their standard deviation & mean values. This indicates that most respondents agreed that inventory accountability influenced the performance of their organization. This section tested the research framework with key variables as inventory management system and organizational performance. Findings indicate that the organization attests to its inventory management system, with majority agreeing that their organization displayed the four inventory management system attributes of inventory control, inventory speed, inventory cost, and inventory accountability. The study also reveals a strong and positive relationship between inventory management system and organizational performance with three variables; inventory speed, inventory cost and inventory accountability being strongly and positively related to organizational performance.

VIII. RELIABILITY ANALYSIS

Reliability of an instrument refers to its ability to produce consistent and stable measures. A reliable measurement will consistently assign the same score to the same phenomena. The most common reliability coefficient is the Cronbach's alpha estimates internal consistency based on the average inter - item correlation. The overall reliability statistic for all the 17 items based on Cronbach's Alpha was 0.8197 as expressed in Appendix-A. The reliability is expressed as a coefficient between 0 and 1.00 and the higher the coefficient, the more reliable is the test. In this study the reliability of the instrument based on Cronbach's Alpha of 0.8197 thus suggested that the 17 items had relatively high internal consistency and thus accepted. A reliability of 0.70 or higher is considered acceptable in most social science research situations.

IX. CONCLUSION

The main aim of this study was to determine the inventory-management practices of SMMEs in Pune. This study was motivated by the dearth of research on inventory management practices of SMMEs. To achieve the fore mentioned aim, a questionnaire survey was conducted.

1. This study makes several contributions to inventory-management practices literature. It is the first study to investigate the usage of inventory-management practices in SMMEs in the Pune city. Consequently, it fills the gap in knowledge through the investigation of

the inventory-management practices primarily used by SMMEs. SMMEs are generally neglected in research as they lack financial resources required to finance their own research at the level that larger entities do.

2. Unlike the prior studies which covered inventory management as an implied ‘technique’ under the broader topic of ‘working capital management’, this study focused on inventory-management practices of SMMEs thus provided a more in-depth account of the practices of these entities, their effectiveness and challenges when managing inventory.
3. Most prior studies covered larger entities and very few focused on SMMEs. This study therefore adds to the body of knowledge insights on inventory-management practices of small businesses, which are the lifeblood of the Indian economy.
4. This study is also significant to academics who can adopt and adapt the research methodology and questionnaires employed in this study to explore other inventory management practices not encompassed in this study. It can also be significant to academics who may replicate the survey in other sectors and areas and even among micro entities in order to confirm the validity of the findings of this study.
5. This study investigated four key inventory-management practices while other prior studies examined the use of one singular IM practice. The results of this study thus provide a rich and broad spectrum of knowledge which will greatly add to the already existing body of knowledge.
6. The findings can also be used in curriculum creation by using the direction the results of this study have provided to give structure on short courses that can be offered in training institutions. These courses can then be offered specifically to small businesses and used to improve the usage of best inventory-management practices among SMMEs.

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