Enhancing Material Management in Building Construction Project

Yohannes Tedla Kebede[1], Dixit Patel[2]
[1] M.Tech student, Civil Engineering Department, Parul University, Vadodara, Gujarat, India
[2] Assistant prof., Civil Engineering Department, Parul University, Vadodara, Gujarat, India

Abstract: Construction material management plays an important role in the world as it develops and achieves the goals of the society. This research has scrutinized the current material management in building construction projects. An important factor badly affecting the performance of construction project is the inappropriate handling of materials during site activities, materials scarcities, delays in supply, price variations, damage and wastage, and lack of storage space. The aim of this research study will be to improve material management in construction projects by identifying factors affecting construction material management especially in the building construction project. The research study is limited to large Residential and commercial building construction projects in Vadodara city. 100 factors should be considered in this survey were 25 major factors were taken for each stakeholders (contractors, store incharge, project engineers and site supervisor). Data for the study are obtained through a structured questionnaire administered to respondents in number of 127. The data obtained from participants` were analysed by Relative importance index (RII) method and ranked accordingly.

Keywords: Construction materials, inventory control, Material Management, Radio Frequency Identification, Relative important index (RII) method.

I. INTRODUCTION

Construction industry contributes a major economic disbursement in India. It is the second largest economic activity next to agriculture. Materials management is an essential element in project management. Effective materials management is a basic fundamental for achievement of a construction project. For many years it has grown and changed with respect to the continually growing complexity of projects. Materials constitute a major cost component for construction Industry. The total cost of materials may be 60% or more of the total cost incurred in construction project dependent upon the type of project and the extent of mechanisation and plant used Khyomesh V. et (2011) [1]. Material management is a task that pointedly contributes to the achievement of a project. As projects develop in scale and difficulty, material management is required really to use them. It remains the process that coordinates planning, purchasing, transporting, receiving and inspection, storing, handling and controlling of materials, reducing the wastage and optimizing the productivity by minimizing cost of materials. Material management should be measured in construction projects as an energetic management to achieve superior productivity and profit, which should be interpreted into cost discount and successful completion with best quality. It is surely that material management performs increase efficiency in operations and reduces overall costs.

A. Aims of the Research

The aim of this study will be to improve material management in construction projects by assessing problems of material management and to facilitate the management of construction materials mainly in the building construction.

B. Objectives of the Research

1) To improve the current practices of construction material management.

2) To identify factors affecting material management in construction project.

3) To give recommendation for the major factors that affect effective material management.

II. LITERATURE REVIEW

A properly executed materials management plan can attain the timely movement of materials and machineries to the workplace, and thus simplify enhanced work expression planning, increased employment productivity, better timetables, and lesser project costs Aditya A. Pande (2015)[2]. The major problems in delaying construction projects are poor material management. The material management arrangement attempts to insure that the right quality and quantity of materials are properly selected, bought, transported and handled on site in a timely manner and at an equitable cost. In every construction project the three inter-related factors of time, money and quality necessity to be controlled and managed. To achieve a profit, there is necessity to change process of material management. By using ICT technique, exact consumption of material, stocked material, and position of material can be found. It reduces labor-intensive error and it is easy to communicate. Successful completion of projects needs all properties to be effectively managed Abhilin G B (2017) [3].

According to Narimah Kasim (2003) [4] Emerging technologies (such as wireless system, RFID) are not being sufficiently used to overcome human mistake and are not well integrated till now with project management constructions to make the stalking and

management of materials easier and faster. By assessing the information and communication technology tools and techniques presently being employ on construction projects. The findings from literature review expose the necessity for more sophisticated materials management resolution in order to advance tracking of materials efficiently. The nature of computerization of materials management procedure will develop new ICT approaches for enhancing materials management practices.Hemishkumar Patel (2015) [5] Conclude that Poor materials management can be leaded to increased costs during construction. Proficient materials management can cause consequences in considerable savings in project costs. Materials may deteriorate during storage or get stolen unless special care is taken. Delays and additional expenses might be acquired if materials required for particular activities are unavailable.

Factors affecting material management for the selected case study of building sites and usage of right materials in the right place at the right time are important for effective execution of a building project. The research concluded that Material management leads to effective cost control, to improve the quality and time execution of their projects and reduces failure of a project DR. Kevin Aku Okorocha [6]. Khyomesh V. et. (2011)[1] Conducted that prolific and cost efficient material management practices are essential in construction industry. The research indicates construction materials constitute about 70% of the entire cost for a typical construction project. Suitable management policies and practices are needed for this component which will create the productivity and cost efficiency of the project and in this manner helping the timely accomplishment of the project. Emerging technologies are not being adequately used to overcome human error and are not well combined with the project management systems to make the tracking and management of materials easier and faster. Therefore, this paper reports on the early phases of research which is enhancing a new ICT-based approach to managing materials on construction projects. The objective of the current study is to know about the problems occurring in the organization because of inappropriate application of material management Anup Wilfred.et (2015) [8].

Ms. Priyadarshani. et.al (2017) [9] Identified most of contracting firms are considered the main problems in using computer in material management are lack of user-friendly computer program and no understanding for importance of computer program. Improper cutting of material in every construction was one of the most significant factors affecting on material waste. The investigation also showed that the permanent of the work and work characteristic was one of the most essential factors affecting on increasing productivity. According to A.A Gulghane .et (20[7] Materials management practices require a transformation throughout the project to improve the overall in handling of materials for more productivity and success on the construction site. For this reason poor handling of construction materials disturbs the whole performance of construction projects in terms of cost, time, quality, and productivity. Harsh Soni, (2016) [10] Deals with identification of selective inventory control technique to preserve adequate stock of raw material during the period of short supply, to prevent inventory against deterioration and control investment in inventories and to keep it at the highest level by using an inventory control techniques such as ABC, SDE and EOQ analysis. P.Ezhilmathi. et. (2016) [11] Cost overrun is the most significant problems that burden project progress, since it decreases the contractor's profit leading to enormous losses, and leaving the project in great troubles. The real materials management plan develops an institutional master plan by filling the gaps and producing an environmentally liable and resourceful outcome.

III. RESEARCH METHODOLOGY

Research methodology is a way to systematically solve the research problem. The research strategy adapted for this research is quantitative research. Quantitative research is chosen to know stakeholders perception regarding material management

The structured questionnaire is the most widely used data collection technique for conducting surveys.

IV. DATA COLLECTION

In this research, data collection has been carried out by questionnaire survey. The questions of the research questionnaire are constructed based on: Literature review and several interviews with contractors to identify different factors in construction projects. The questionnaires were distributed to project engineers, contractors, site supervisors and store incharge.

To obtain a statistically representative sample of the population, the following formula has been used.

$$n = \frac{m}{1+[\frac{m-1}{N}]}$$

Where n, m and N = the sample size of the limited, unlimited and available population, respectively. m is estimated by the following equation.

$$m = \frac{z^2 * p * (1-p)}{e^2}$$

Where z = the statistic value for the confidence level used, i.e. 2.575, 1.96 and 1.645, for 99%, 95% and 90% confidence levels, respectively; p = the value of the population proportion that will be estimate, and e = the sampling error of the point estimate. Because the value of p is unknown, Sincich et al. (2013) [11] propose a conservative value of 0.50 be used so that a sample size that is at least as large as required be obtained. By using 95% confidence level, i.e., 5% significance level, the unlimited sample size of the population, m, is approximated as follows:

$$m = \frac{1.96^2 * 0.5 * (1-0.5)}{0.05^2} = 384$$

Accordingly, for the total number of 150 stockholders from Vadodara city contractors 40, project engineer 37, site supervisor 38 and store incharge 35. The collected questionnaires are above the expected questionnaire which is 127. Therefore, for this research it is very good. Because the expected questionnaire are 108

$$n = \frac{384}{1 + [\frac{384-1}{150}]} = 108$$

V. RESULTS AND DISCUSSIONS

In order to attain the intended objectives of the study the data obtained from participants` were analysed by RII method and ranked accordingly. 100 factors should be considered in this survey were 25 major factors were taken for each stakeholders (contractors, store incharge, project engineers and site supervisor). Top ten factors were listed in the following results and discussions.

$$RII = \frac{\sum W}{A \times N}$$

The questionnaires were analyzed based on the given scale.
Very little degree affects =1 little degree affect=2
Mid degree affect =3 High degree affect=4 Very high degree affects=5
The following factors are calculated by using RII methods. For examples:

$$RII = \frac{\sum(2*1+3*2+6*3+13*4+8*5)}{5*32} = 0.7375$$

Table 1: Data analysed for contractor

Factors affecting material management	1	2	3	4	5	RII	Rank
Delay of the project compilation	2	3	6	13	8	0.7375	1
misuse of the specification	2	4	5	15	6	0.71875	2
Poor skills and experience of labor	4	5	8	6	9	0.66875	3
Cost overrun.	2	8	7	11	4	0.64375	4
Coordination problems with others	5	3	12	5	7	0.6375	5
Shortage of materials on site	6	5	5	11	5	0.625	6
Rework due to improper quality and mistakes	4	7	9	7	5	0.6125	7
Time extension.	5	4	12	8	3	0.6	8
Contractors Rework	5	7	7	9	4	0.6	8
Construction mistakes and defective work	7	8	5	4	8	0.5875	10

From the contractors' perspective

Table 1: shows that the contractors ranked Delay of the project completion in the first place with the high relative importance index of 0.7375. This indicates how right of way problem affect the project time. If there is a right of way problem in construction project it will lead to a significant delay in a project.

The second important factor ranked by contractors was misuse of the specification with the relative importance index of 0.71875. In the above analysis top fifteen factors ranked by RII methods are highly affects materials on construction sites. The suitable description of this agreement is that Poor skills and experience of labor and cost overrun has also highly affects in delaying construction projects.

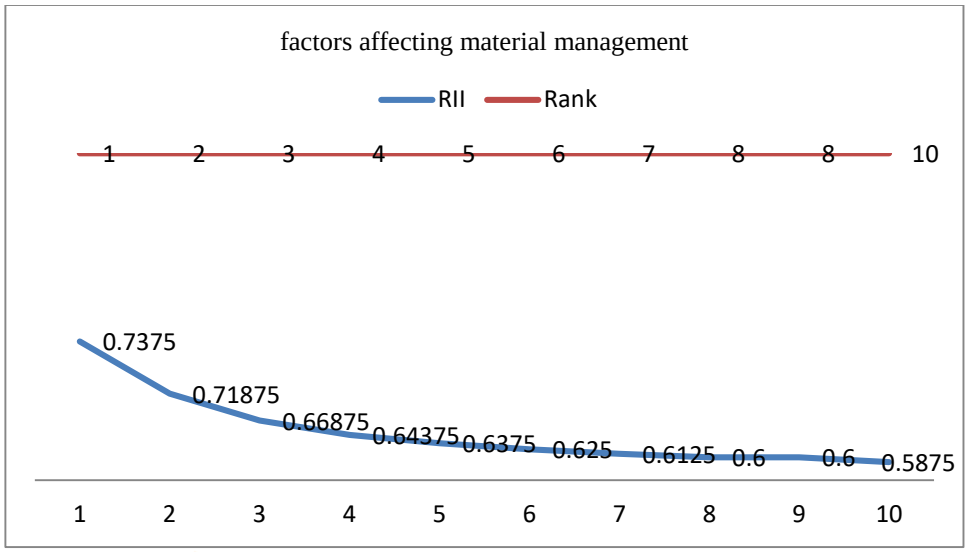

Figure 1: factors affecting material management ranked by RII methods

NB: the horizontal axis-x (1-10) indicates that top ten factors listed in the above table

Table 2: Data analyzed for store incharge

Factors affecting material management	1	2	3	4	5	RII	Rank
Lack of supervision and proper control during storage	2	6	6	9	8	0.61290	1
Using unsuitable places for store materials	4	5	6	7	9	0.6	2
Poor materials storage facility	5	3	7	12	4	0.56774	3
Burglary, theft and vandalism	3	6	6	12	4	0.56774	3
Ineffective control of storage	4	8	5	5	9	0.56129	5
Over-ordering of materials	8	4	5	7	7	0.54838	6
High frequent materials movement	5	5	6	12	3	0.54193	7
Employment of store keeper and security personnel	4	6	7	8	6	0.54193	7
Controlling over-ordering and purchasing	6	6	5	10	4	0.52903	9
Reporting the situation of materials in the project's store	3	9	5	11	3	0.52258	10

From store manager/store incharge perspective

Table 2: shows that store manager ranked lack of supervision and proper control during storage in the first place with the relative importance index of 0.6129. This indicates that materials management is highly affected by poor supervision and proper control. Using unsuitable places for store materials are ranked on the second places with the relative importance index of 0.6. This leads to damage or deterioration and increase waste in storage with a high degree affect.The third important factor ranked by store manager was Poor materials storage facility with the relative importance index of 0.56774. This implies that improper storage leads to increase wastage on construction sites. The above top ten factors ranked by RII methods are highly affects construction material. Therefore, it is important to implement a construction materials management system to overcome most of material management problems such as ineffective control of storage, late delivery to the site, over ordering of material etc..

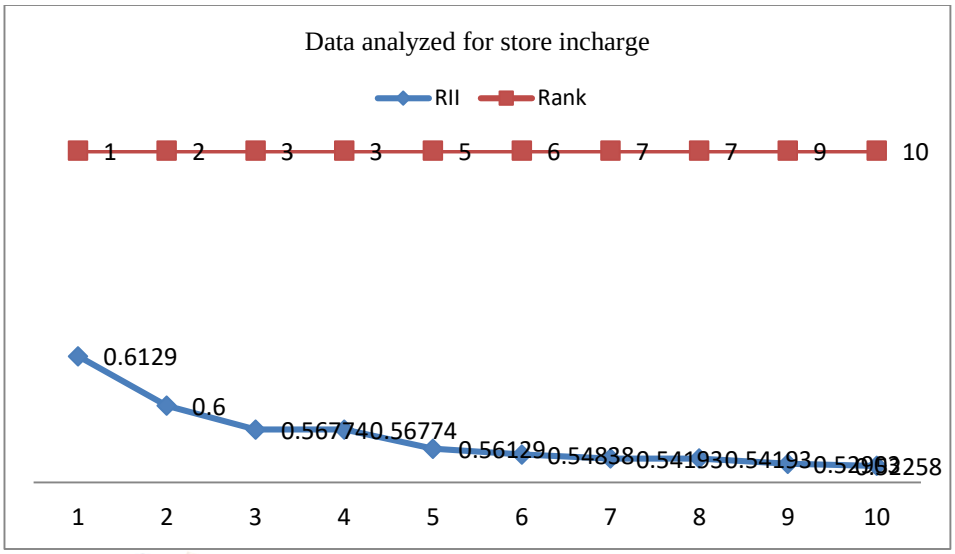

Figure 2: factors affecting material management in storage ranked by RII methods

NB: the horizontal axis-x (1-10) indicates that top ten factors listed in the above table

Table 3: Data analyzed for project engineers

Factor affecting material management	1	2	3	4	5	RII	Rank
Misunderstanding of owner`s requirements by design engineer	3	6	4	10	9	0.7	1
Delay in performing inspection and testing by the consultant team	3	5	7	11	6	0.675	2
Slow response from the consultant team to contractor inquiries	2	7	6	13	4	0.6625	3
Owner's delay in handing over the site to the contractor.	4	5	7	9	7	0.6625	3
Unavailable required quantity	3	5	10	7	7	0.6625	3
Improper cutting of materials	2	6	13	3	8	0.65625	6
Communication problems	4	4	8	11	5	0.65625	6
Materials damage on site	3	6	11	4	8	0.65	8
Poor qualification of consultant engineer’s staff assigned to the project.	4	8	5	7	8	0.64375	9
Burglary, theft and vandalism.	3	7	12	2	8	0.63125	10

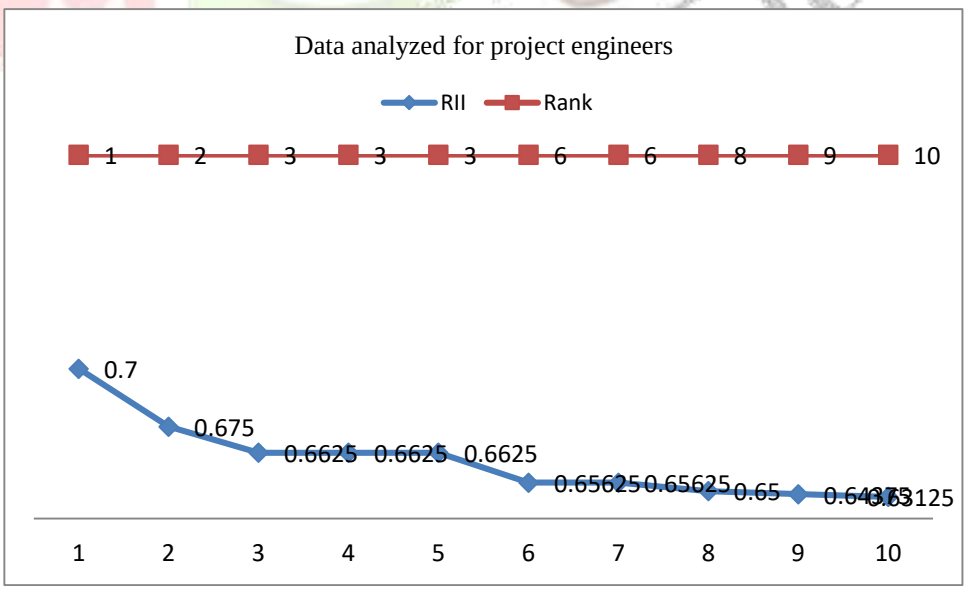

Figure 3: factors affecting material management in construction site ranked by RII methods

NB: the horizontal axis-x (1-10) indicates that top ten factors listed in the above table

From project engineers perspectives

Table 3: shows that project engineer ranked misunderstanding of owner`s requirements by design engineer in the first places with the relative importance index of 0.7.This indicates that it is high degree affects the whole design projects to progress. Delay in performing inspection and testing by the consultant team ranked on the second with the relative importance index of 0.675. The results show that ineffective contracting team on the project progress can highly influences the completion of projects on time. They believe that the factors which have high degree affect i.e. Materials damage on site, communication problems, improper cutting of material, unavailable required quantity, and slow response from the consultant team to contractor inquiries, Improper handling of materials on site. On the other hand, the factors which have highly influenced to increase loss of construction material on site were Burglary, theft and vandalism. To solve the problems giving sufficient instruction and proper communication within the construction team is very necessary.

Table 4: Data analyzed for site supervisor

Factors affecting material management	1	2	3	4	5	RII	Rank
Providing project team with insufficient information	3		11	12	6	0.7125	1
Poor qualification of the contractor's technical staff assigned to the project	3	4	9	7	9	0.69375	2
Poor supervision and delay in giving instructions	1	5	8	14	4	0.69375	2
Poor material selection	2	5	9	9	7	0.6875	4
Poor qualification of the contractor's technical staff assigned to the project	3	5	6	11	7	0.6875	4
Wrong material utilization	4	7	2	10	9	0.68125	6
Incorrect material takeoff from drawing and design documents.	4	4	4	16	4	0.675	7
Slow response from the consultant team to contractor inquiries	3	5	6	14	4	0.66875	8
Poor qualification of consultant engineer's staff assigned to the project.	2	5	10	11	4	0.6625	9
Delay in performing inspection and testing by the consultant team.	3	6	7	11	5	0.65625	10

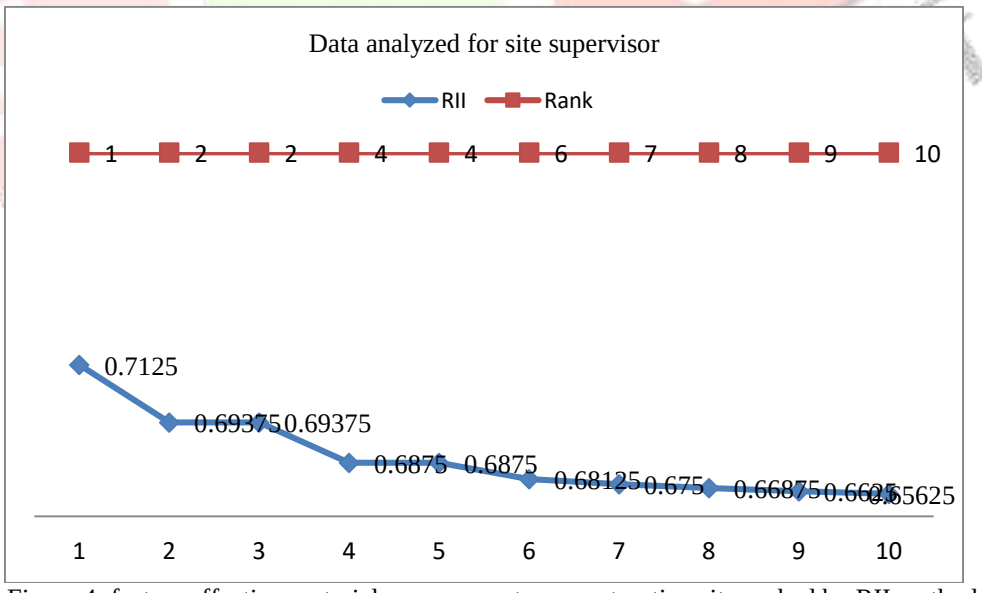

Figure 4: factors affecting material management on construction site ranked by RII methods

NB: the horizontal axis-x (1-10) indicates that top ten factors listed in the above table

From site supervisor perspective

Table 4: shows that site supervisor ranked providing project team with insufficient information in the first places with the relative importance index of 0.7125. Poor qualification of the contractor's technical staff assigned to the project was ranked by site supervisor on the second places with the relative importance of 0.69375.This indicates that Poor supervision and delay in giving instructions and unskilled technical staff has highly affects material management on sites. On the other hands Poor material selection, Wrong material utilization, Poor qualification of consultant engineer's staff assigned to the project, incorrect material takeoff from drawing and design

documents causes high impacts on construction material. Rechecking and taking corrective action during supervision can solve the problems of mismanagement in construction industry.

VI. CONCLUSIONS AND RECOMMENDATION

A total of 100 major factors are identified which highly affects material management. These factors are classified under contractors, store incharge, project engineers and site supervisors by 25 major factors.

- According to the contractors responses the results indicated that "delay of the project completion" has been ranked in the first position with the relative importance index of 0.7375. This result indicates that effective use of time will be very important to complete the project on time. Due to delay of project completion many problems will be happen such as disputes between contractors and clients, time and cost overrun, damage of construction material etc...
- The results indicated that "misuse of the specification" has been ranked in the 2nd position by contractors. This indicates that using correct specification should be required for construction projects. Any use of wrong specification in construction projects will cause damages on the projects.
- The factor of "poor skills and experience of labor" has been ranked in the 3rd places by contractors. This result indicates that skilled manpower will be very important in the progress of construction project.
- "Cost overrun "has been ranked in the 4th places according to contractors perspectives. This result indicates that cash is very important in the progress of any construction projects. Cost overrun will cause great loses specifically on contractor.
- Based on project engineers view factors such as; misunderstanding of owner`s requirements by design engineer, delay in performing inspection and testing by the consultant team and Slow response from the consultant team to contractor inquiries are highly affects material management.
- According to store incharge perspective the main factors which affect material in storage are lack of supervision and proper control during storage, using unsuitable places for store materials, poor materials storage facility, burglary, theft and vandalism and ineffective control of storage.
- Site supervisors are also ranked the major factors such as: providing project team with insufficient information, poor qualification of the contractor's technical staff assigned to the project, poor supervision and delay in giving instructions and Poor material selection.

The following recommendation could be taken to all parties for effective construction material management.

- Contractors are recommended to setup stores for required construction materials to avoid problems of delay in project completion. Effective use of time will be very important to complete the project on time.
- Project engineers are recommended to develop the habit of cross checking among clients, consultants and contractor to avoid misunderstanding and slow response from the team.
- Helping the store manager to understand the system by initiating training courses, lectures, seminars, modeling sampling and workshops to prevent problems such as: lack of supervision and proper control during storage, using unsuitable places for store materials, poor materials storage facility, burglary, theft and vandalism and ineffective control of storage.
- Site supervisors are recommended to provide sufficient information to the project team to minimize poor supervision and delay in giving instructions and Poor material selection.

Construction Ministers, road and building office of Baroda, Contractors Unions, Engineering Associations and Universities have to do more efforts to improve the existing construction materials management practices, which may include:

- Transferring of technology and experiences of other universities, cities and countries in the construction materials management field and adapting them to suite in Vadodara.
- Encouraging the contractors and store manager to use construction materials management systems by addressing the importance and impact of these systems.
- Contractors are recommended that proper care is taken in the project planning and scheduling stage. It is essential to hire knowledgeable contractors in the construction projects for timely completion of project and do not allow regular changing of subcontractors in between project tasks.
- contractor are advised to adopt efficient information distribution systems to guard against communication gaps; respond as soon as possible to site supervisor and store incharge questions and requests for clarification to avoid associated delays and confusions which consequentially will lead problems of material management.

VI. FUTURE WORKS

- Implication of using newly emerging technologies in order to develop current practice in construction material management scheme
- Effective management of material during construction
- Study can be done to identify the main factors that cause problems, obstacle and impacts.
- Study can be done to measure the effectiveness of the projects by using the identified factors.

VII. ACKNOWLEDGMENT

The author would like to acknowledge to my supervisor Assistant prof. Dixit Patel for his continual and valuable help and motivations to complete my work.

REFERENCES

[1] Khyomesh V. Patel," Construction Materials Management On Project Sites" National Conference on Recent Trends in Engineering & Technology, 13-14 May 2011

[2] Professor, Aditya A. Pande and S .Sabihuddin", "Study of Material Management Techniques on Construction Project ", Volume 2, Issue 9, May 2015

[3] Abhilin G B, and Vishak M S", "Effective Material Logistics in Construction Industries" International Journal of Science and Research (IJSR) Volume 6 Issue 3, March 2017

[4] Narimah Kasim, "Improving Materials Management Practices in Construction Projects", International Symposium in Developing Economies commonalities among diversities, January 2003

[5] Hemishkumar Patel, Dr. Jayeshkumar Pitroda, Prof. J. J. Bhavsar, "Analysis of Factor Affecting Material Management and Inventory Management: Survey of Construction Firms in Gujarat Region of India" Volume 1, Issue 10 May2015

[6] DR. Kevin Aku Okorocha, Ph.D., RSV, "Factors Affecting Effective Materials Management In Building Construction Projects- A Case Study Of Selected Building Sites, In Imo State, Nigeria", International Journal of Management Sciences and Business Research Volume 2, Issue 4- ISSN (2226-8235)

[7] A.A Gulghane and Prof P. V. Khandve, Management for Construction Materials and Control of Construction Waste in Construction Industry: A Review, Int. Journal of Engineering Research and Applications Vol. 5, Issue 4, (Part -1) April 2015, pp.59-64.

[8] Prof. Anup Wilfred. S, Mr. Deepak M.D .Mr. N. Shivaram3, Mr. Nataraj M.Mr Yaseen Khan, An Empirical Case Study of Material Management In Residential Project, Journal of Engineering and Technology: Volume: 02 Issue: 04, July-2015

[9] Ms. Priyadarshani N. Mane , Dr. A. K. Gupta & Prof. D. B. Desai, A Review Paper on Onsite Material Management for Construction Projects , Imperial Journal of Interdisciplinary Research (IJIR) Vol-3, Issue-2, 2017.

[10] Harsh Soni, Dr. Jayeshkumar Pitroda, Prof. J.J.Bhavshar", "Analyzing Inventory Material Management Control Technique on Residential Construction Project", Vol-2 Issue-3 2016 IJARIIE-ISSN (O)-2395-4396

[11] P.Ezhilmathi, Dr.T.Shanmugapriya & Sri Ramakrishna, Study On Material Management – An Art Of Review, International Research Journal of Engineering and Technology: Volume: 03 Issue: 11,Nov -2016