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Critical Analysis of Material Management in Apartment Building

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Abstract: ***An essential part of the building industry is materials management. Organizations must therefore comprehend how appropriate materials management strategies affect how well projects are carried out. When a materials management programme is executed correctly, it is possible to ensure that equipment and materials are delivered to the jobsite on time. This leads to better scheduling, enhanced labour productivity, better work face planning, and reduced project costs. Enhancing efficiency in building projects requires effective materials management. Planning and material takeoff, vendor evaluation and selection, purchasing, spending, shipping, material receiving, storage and inventory, and material distribution are all considered materials management tasks. We have prepared a material management plan for building projects in the construction industry as part of this project. Additionally, a study of the industry is being conducted to ascertain the various formats for construction material management. The industry's tracking system for material management is also being discussed, as is the software technology created for effective management.***
Keywords: Risk management, project, small scale enterprise

I. INTRODUCTION

Materials is main role in construction project and also main cost component in construction sector, materials can take 50% and above of the total cost of project. The main aim of material management to reduce the cost of project by using different techniques, Material management is defined as "the process to provide right material at right place at right time in best quantity so as to minimize the cost of project".

The goal of material management is to ensure that construction material are available at right quality of material and quantity of material are appropriately selected, purchased, delivered and handle on site in a timely manner and at reasonable cost. Material management place a major role in project management, to minimize the procuring, cost material should be procured within the time; delay in the material procuring leads to increase of construction cost efficient management of material can help to save the project cost. Timely flow of material is a crucial factor of material management, if u procures more material before by dumping in a site it leads to stolen of material, damage of material, if and every material has its own properties and performance of material should be compared. This performance may defer from system to system, the material should be used the efficiently by maintain them by storing in a perfect place without occurring any damage to them. The flow of material should be ordered and received and stored until they are use adequately. Basically material management is associated with receiving, procuring storage, identification and planning the increases the population as well as economic growth. The construction activities as been increasing rapidly, so the amount of construction waste has been the waste material can also be reutilize in construction. Different material taken from the waste can be used for various purpose those waste generation thought the construction storages needed to be identification and quantified to decrease the wastage.

II. LITERATURE REVIEW

Author presents a proposal for a methodology, which allows to determination and comparison of the inventory management costs in enterprise conducting parallel works on several construction sites. *Lukasz Rzepecki, (2019)* during planning the execution of each construction project, the factors that may affect the effectiveness of its realization should be analyzed in detail. The costs of execution construction projects are significantly influenced by (apart from technical factors) decisions in the field of inventory management, among others, variability of environmental conditions, prices of construction products, the ability to acquire local suppliers, distance of transport, limited size of storage for construction products as well as the individual character of the project. In projects related to the buildings erection and other construction works, there are many logistical tasks in the area of supply in construction products, raw materials, equipment, as well as in the area of financial and information flow.

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Taking into account the large share of material costs, inventory management in the costs of projects realization and the high potential for their reduction, every enterprise operating in the construction industry should pay a great importance to the supply logistics sector. Determination of the size and delivery times of construction products, as well as the transport routes, storage and reloading locations are decision-making problems that are solved by management of both the enterprise and the construction projects. in this paper mathematical models have been developed which simulate the functioning of supply logistics systems and allow, through their solution, to determination of the minimum logistics costs with optimal arrangements for the supply schedule (delivery volumes in subsequent periods of the project execution). This is the foundation for the selection of the optimal variant of a supply chain management. The practical application of the methodology proposed is illustrated using an example.

Sayali Shet, Raju Narwade, (2017) the average material cost is 55-60 % of total project cost. Hence, efforts should be taken to reduce material cost. In actual practice most effort are done to reduce labour cost. Furthermore effective material management can be instrumental in cost reduction to further extent. The cost, quality & time are important objective of material management. There are various functions of material management .These are identification with estimation of material requirement, procurement, inventory control, storage, disposal of surplus material & scrap. If material is purchased too early, capital gets tied up as well as, interest charges incurred on excess inventory of material. On other hand if material availability at site is delayed it will affect scheduling of activities. Advance material procurement or delayed both can affect cost, quality & time. So it is very important to get material at right cost, at right quality & right time. This can be achieved by using material management techniques. The ABC analysis, VED analysis & SDE analysis are different techniques of material management. These techniques can lead to effective material management in construction projects. ABC analysis is based on inventory value of material.VED analysis gives Priority to utility of material whereas SDE analysis gives availability of material in market.

Materials management is a critical component of the construction industry. As such, organizations need to understand the effects of proper materials management techniques on the effectiveness of project execution. *Sachin S. Pal, Prof. Himanshu Ahire, (2016)* A properly implemented materials management program can achieve the timely flow of materials and equipment to the jobsite, and thus facilitate improved work face planning, increased labor productivity, better schedules, and lower project costs. Materials management is an important function in order to improve productivity in construction projects. It is defined materials management functions which include planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution. In this project we have prepare scheme of material management in The construction industry for building project .Also conducting survey of industry and determine the various format for construction material management also discussing the tracking system of material management in the industry and also discuss the soft ware technology developed for proper management are discuss.

In recent treads a wide range of building materials is available for the construction of civil engineering structures. The total cost of materials may be up to 60% or more of the total cost incurred in construction project dependent upon the type of project. Effective construction materials management is a key to success for a construction project. *A. Gulghane, Prof P. V. Khandve, (April 2015)* Construction waste is another serious problem in construction industry. A large and various types of construction waste with different characteristics are created at all the stages of construction. Construction industries have a larger part in contributing environmental problems. The economic and environmental benefits must be gained from construction waste minimization. This paper presents a review on systematically investigation of the management of construction materials and construction waste, material management techniques, control of construction waste and existing situation of construction management and construction waste in the industry.

Inventory Classification is very important to manage inventory efficiently. Popular concept - Importance and Exception (CIE) is employed to ensure that efficiency is maximized with least effort. *Dinesh Dhoka, Dr.Y.Lokeswara Choudary, Dec. 2013* For inventory optimization and Inventory Forecasting, products need to be classified appropriately. There are several methods used for categorization of products and items in inventory. Most common classification used is the Pareto Analysis. The focus of this paper is to check if some assumptions for ABC Analysis are taken for granted

Materials management is an integrated process that consists of the people, organizations, technology, and procedures used to effectively identify, quantify, acquire, expedite, inspect, transport, receive, store, and preserve the materials, equipment, and associated information across the life cycle of a capital project. *Carlos H. Caldas, Cindy L. Menches, Pedro M. Reyes, (2014)* the goal is to ensure that the correct quality and quantity of materials and equipment are procured in an effective manner, obtained at a reasonable cost, and available when needed. The implementation of a comprehensive materials management program contributes to more-predictable project outcomes, reduced costs, improved productivity and quality, and a safer working environment. This makes the early and comprehensive involvement of materials management in capital projects very important.

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This paper 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 accomplish this purpose. The study clearly shows a dramatic increase in the maturity, formality, and systematic approach to materials management.

III. MATERIAL MANAGEMENT

A. *Material Management Challenges On Construction Site*

Materials management can be divided into five categories:

1) The measurement and specification;
2) The procurement and purchasing process where the order is transmitted to the supplier;
3) Delivery to site and logistics of checking the order, off loading, and storing on site;
4) The administrative and financial process of payment;
5) Using the materials in production on the job site and removing the waste.

In terms of purchasing and supply of materials, not matching materials with the ordering purchase, forgetting ordering materials, over or less materials, early or late materials arriving, lack of JIT strategy, lack of training and adequate management, lack of communication and relation between contractor and supply chain companies are the main obstacles. Some common problems on construction site are more obvious which are namely:

Failure to order on time which delays the projects;

6) Delivery at the wrong time which interrupts the work schedule;
7) Over ordering;
8) Wrong materials or error in direction of materials requiring re-work;
9) Theft of materials from delivery into production;
10) Double handling of materials because of inadequate material.

In terms of logistics, the main problems are wrong time of materials arriving to the site or even wrong quality, lack of information for materials arrival to the site or site stock, missing materials, unavailability of storage space, and waste of labour for materials searching on site. The research has identified a gap between the procurement and ordering of materials and the delivery and use of the material on site at the production stage. This paper deals with this one aspect of materials management and focuses upon how technology can help to improve the tracking and delivery of the materials. Consideration is given to how GPS and GIS can be used to help SMEs in managing the process.

B. *Impact Of Effective Material Management On Construction Site Performance For Small And Medium Sized Construction Enterprises*

A construction project depends upon having the right people with right skills and equipment that are able to deliver the project on time and on budget. Having the right materials in the right place at the right time is equally important, and having the cash flow and capital to procure the labour and materials is also important. The materials on a project can represent anything from 30% to 70% of the cost of the work, yet materials management has not received a lot of attention from researchers. The research is based on three propositions.

1) SMEs tend to undertake little detailed construction planning of activities, they work to milestone dates which mean procurement and materials management is not properly scheduled with sufficient lead times for delivery.
2) Materials and component manufacturers and suppliers, and builder merchants have invested heavily in developing IT based control systems to track their materials through the production, warehousing, and delivery process up to the point of delivery to site. The data and information are not then transferred to the SME and the delivery system fails to help the SMEs to manage materials on the site.
3) Significant savings could be made by SMEs with the better management of materials on site and the use of technology systems leading to reduced waste of materials and better site productivity through more efficient handling of materials with lower wastage.

Labour, material, tools, equipment and cash are the main parts of any construction project. Material management is the system for planning and controlling to ensure that the right quality and quantity of materials and equipment are specified in a timely manner. Materials should be obtained at a reasonable cost, and be available for use when needed. The cost of materials represents a large proportion of the cost.

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Our analysis of project cost for civil engineering projects showed the materials and plant component can be up to 70% of the project cost dependent upon the type of project and the extent of mechanisation and plant used, whilst on commercial building and housing projects the proportion is around 45%-50%. The sample size used was small, nine projects, however in interviews with estimators the findings were validated by professional judgement. A good management system for materials management will lead to benefits for construction. Cash flow has become crucial for the survival of any business, if materials are purchased early, capital may be tied up and interest charges incurred on the excess inventory of material. Material may deteriorate during storage or be stolen; also delays and extra expense may be incurred if materials required for particular activities are not available.

C. Methodology and Methods

The study adopted a closed-ended questionnaire survey designed to examine the impact of construction materials management on materials usage efficiency towards the enhancement of sustainable building construction. This study identified fifteen materials management strategies considered during materials selection, thirteen factors that facilitate materials usage and eight approaches to materials usage towards enhancement of sustainable construction. Data collection was conducted using the cluster sampling technique from construction industries. This technique was adopted in order to obtain precise data with generalizable conclusions from companies in the district. The questionnaire design adopted the five point Likert scale and was administered by hand to two principle target groups. These groups are government establishments and private companies. These groups were selected because of their significant function in the construction supply chain and because their perceptions would be highly valuable to this research. In order to explicitly gain their perceptions, the target groups were sub-divided into site managers, project managers, architects, quantity surveyors, contractors, procurement officers and company suppliers.

D. Overview of the Study Methodology

Initially, a background review was conducted. Then, a first survey was sent out to gather a preliminary snapshot of materials management practices across the industry. The survey targeted larger companies who are the leaders in materials management to ascertain the best practices presently being adopted and followed by the companies. These would provide a current status of the materials management function in the construction industry and help pave the way forward for smaller companies to identify and adopt effective materials management practices. After the results were analyzed, a second survey and case studies were conducted to gain further insight into modern management techniques identified in the first survey. The second survey and case studies focused on trends and issues the leading industry practitioners foresee for the near future. Learning from the leading practitioners of today would in the future provide necessary guidance to the overall construction industry in order to be better aware and prepared for the potential challenges of adopting the best material management practices

1) Phase I Survey

This preliminary survey questionnaire was drafted by the authors based on the background literature review and the previous research.. The questionnaire started with general questions related to the materials management personnel and organization of the construction company, as well as the various components embraced within materials management. It followed up on these issues with specific questions related to the materials management functions, such as strategic sourcing, materials requirements planning, purchasing, expediting, quality assurance/quality control (QA/ QC), transportation and logistics, and site materials management. The first part of the questionnaire was designed to ascertain the level of implementation of the functions through a series of questions with Likert scale options to capture the various levels of implementations across the organization. The second part of the questionnaire addressed some specific topics, including outsourcing, automated systems, performance assessment (i.e., benchmarking and metrics), and current and foreseen issues impacting materials management.

2) Phase II Survey

After a thorough analysis of the Phase I Survey results, the Phase II Survey was developed to gather further insight and more details into the materials management functions, as well as the current and foreseen issues affecting global procurement and materials management. The first part of the survey was devoted to the functions of the materials management process with a series of statements related to each function. The survey participants were asked to rate their level of agreement with the statement on a five-point Likert scale ranging from strongly disagree to strongly agree, with an option of marking the statement as not applicable if the statement did not relate to the organization practices.

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The second part of the survey addressed the current and foreseen issues with a similar style as the first part. A series of statements was presented with the participants having to rate their agreement on a similar five-point Likert scale as in the first part of the survey. As in the Phase I Survey, the authors maintained full confidentiality of the survey responses and only consolidated results were published without naming any individual or company.

IV. RESULT AND DISCUSSION

A. Function of Material Management Phase I Survey Result

Table 1 Selection of Material Management Practices

Sr. No	Practice, concept, or issue	OWNER			CONTRACTOR		
		Mean	SD	Variance	Mean	SD	Variance
1	Prepare inspection plans	4	1.10	1.22	3	1.34	1.79
2	Involve the materials management group in the project front-end planning	3.5	1.50	2.25	3	1.42	2.02
3	Perform design quality reviews	3	1.33	1.77	4	1.28	1.64
4	Implement agreements with transportation carriers	3	1.41	1.98	2	1.07	1.14
5	Have an integrated materials management computer system	3	1.49	2.21	2	1.51	2.29
6	Have a central warehouse of material and equipment	3	1.48	2.20	2	1.14	1.29
7	Use of metric to assess the materials management process	3	1.35	1.82	3	1.49	2.21
8	Conduct materials management process audits	2.5	1.41	2.00	3	1.35	1.82
9	Give incentives for early deliveries	2.5	1.57	2.46	3	1.15	1.32
10	Use outsourcing to implement some materials management functions	2	1.33	1.77	4	1.01	1.01
11	Experience issues with counterfeit material	2	1.31	1.71	2	1.54	2.39
12	Create routing guides for material transportation	2	0.80	0.64	4	1.40	1.96

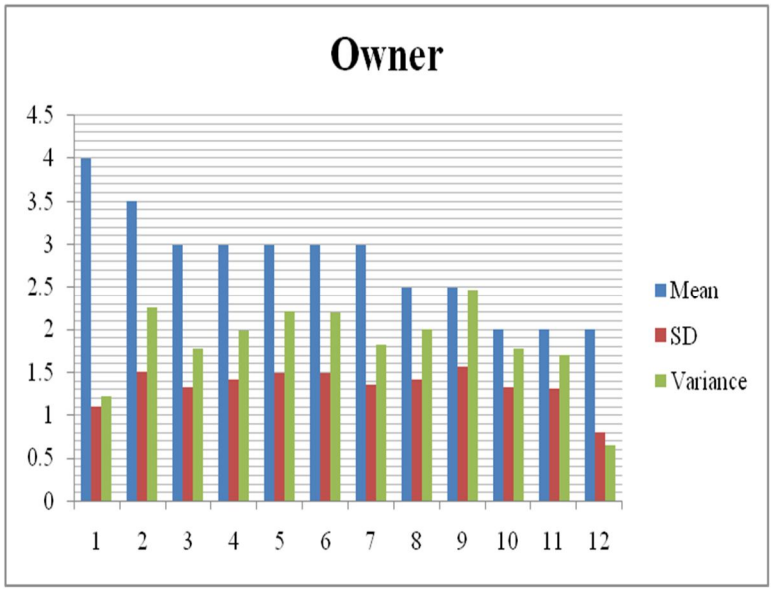


Figure 1 Phase I - Owner Response of Material Management Practices

Figure shows Owner Response of Material Management Practices in graphical form. Result observed “Give incentives for early deliveries” is highest standard deviation and variance for management practices is 1.57, 2.46 respectively and lowest is “Create routing guides for material transportation” 0.80, 0.64 respectively.

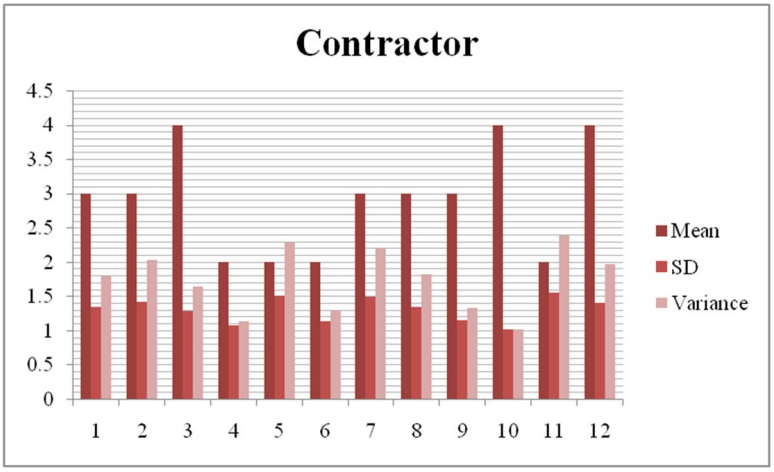


Figure 2 Phase I - Contractor Response of Material Management Practices

Figure shows contractor Response of Material Management Practices in graphical form. Result observed "Experience issues with counterfeit material" is highest standard deviation and variance for management practices is 1.54, 2.39 respectively and lowest is "Use outsourcing to implement some materials management functions" 1.01, 1.01 respectively.

B. Function of Material Management Phase II Survey Result

Table 2 Selection of Material Management Practices

Sr. No	Practice, concept, or issue	OWNER			CONTRACTOR		
		Mean	SD	Variance	Mean	SD	Variance
1	Require the development of a subcontracting plan for each capital project	4	1.20	1.43	4	1.38	1.91
2	Procure materials and equipment from emerging markets	3	1.32	1.73	3.5	1.46	2.12
3	Experienced scheduling challenges as a result of competing demand on the subcontractor's capacity	3	1.21	1.48	3	1.38	1.90
4	Require a written materials management plan for each capital projects	3	1.02	1.04	3	1.40	1.96
5	Track subcontractor's performance	2.5	1.44	2.08	3	1.44	2.07
6	Implement the subcontractor's qualification programs	3	1.23	1.51	3	1.36	1.86
7	Use third-party providers to perform in-shop supplier surveillance	3	1.25	1.56	3	1.21	1.47
8	Experienced an increase in late deliverables	3	1.12	1.25	3	1.53	2.34
9	Use transport and logistics third-party providers	2.5	1.50	2.25	3	1.21	1.47
10	Plan for first-year operation spares	4	1.45	2.11	3	1.23	1.52
11	Use metrics to assess the supplier's performance	3.5	1.35	1.83	4	1.10	1.22
12	Coordination between the materials manager teams and procurement teams	3	1.37	1.89	2	1.54	2.39
13	Engage operations and maintenance personnel in the preparation of the materials management plan	1.5	1.10	1.21	4	1.40	1.96
14	Implement specific policies or procedures for low-cost country sourcing	1	0.57	0.32	3	1.21	1.45
15	Involve site materials management team in the definition of the project execution strategy	2	1.30	1.68	2	1.41	1.98

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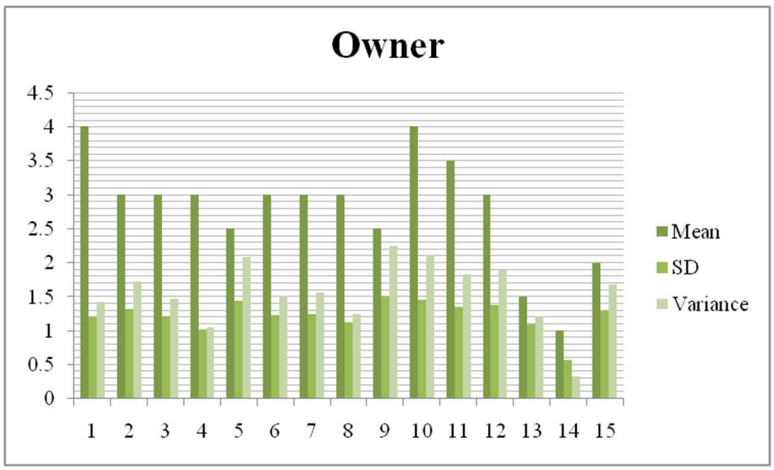


Figure 3 Phase II - Owner Response of Material Management Practices

Figure shows Owner Response of Material Management Practices in graphical form. Result observed "Use transport and logistics third-party providers" is highest standard deviation and variance for management practices is 1.50, 2.45 respectively and lowest is "Implement specific policies or procedures for low-cost country sourcing" 0.57, 0.32 respectively.

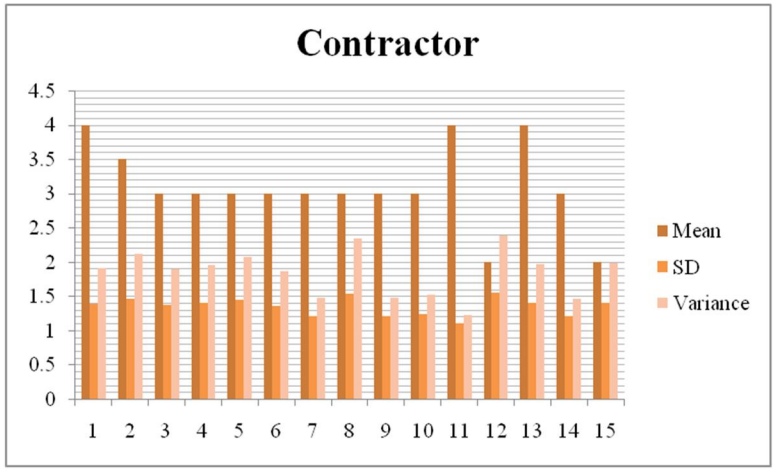


Figure 4 Phase II - Contractor Response of Material Management Practices

Figure 5

Figure shows contractor Response of Material Management Practices in graphical form. Result observed "Coordination between the materials manager teams and procurement teams" is highest standard deviation and variance for management practices is 1.54, 2.39 respectively and lowest is "Use metrics to assess the supplier's performance" 1.10, 1.21 respectively

C. Functions of Material Management

Table 3 Function of Materials Management

Materials Requirements Planning	Project Acquisition Strategy	Purchasing	Subcontracting	Expediting	Transportation and Logistics	Site material management
Identifying, quantifying, and scheduling the acquisition	Identifying the suppliers who can provide the required	Responsibility and control over the authorization of expenditure of project funds for	Develop appropriate subcontracting strategies and plans to service those requirements, identify and validate potential	Guarantee of suppliers deliver material technical data,	Transportation and logistics is to plan, control, and execute the movement of	Right materials and equipment in the right quantities are provided at the right time to the

of project materials and equipment	materials, equipment, and services.	materials and equipment in capital project execution	subcontractors, issue requests for proposals, receive bids, prepare commercial evaluations, negotiate in good faith, commit project funds for the supply of goods and services, and administer the contract		materials to the project jobsite.	construction forces on the project
Materials and equipment required and the acquisition of those materials and equipment influence all projective	Knowledge of industry, company, commodities to be acquired, and existing suppliers	identify requirements and ordering goods and serves		Provide equipment to the project in a timely manner consistent with the terms of the purchase order and the project's requirements and schedules.	Transportation cost	With proper planning and true system integration, material shortages can be identified
Lead time	visit to site and shop	Maintenance of supplier relationships and monitoring of supplier performance measurement are also key activities performed by purchasing		planned, ordered and systematic process of information of our project		
	qualify, certify, perform background check	Maintain quality of product				
application of scheduling strategies	survey		designated along with the responsibility and authority to commit project funds for contractor services and equipment	Estimation of quantities	calculate transportation cost, ordering cost, purchase cost of material	

V. CONCLUSION

1) Due to improper scheduling and controlling to delaying the project it will increase the time and cost. Because of errors in RCC design drawings, it causes problems to the contractor and it causes time and cost overrun, if the deviation occurs in materials or items, it shows an effect on material procurement and it shows the effect on total project cost. Sometimes, material fluctuations may give profit or loss to contractor or client.

2) Material classification has to be done or followed in the site practices to identify the materials based on the importance during the project plan period.

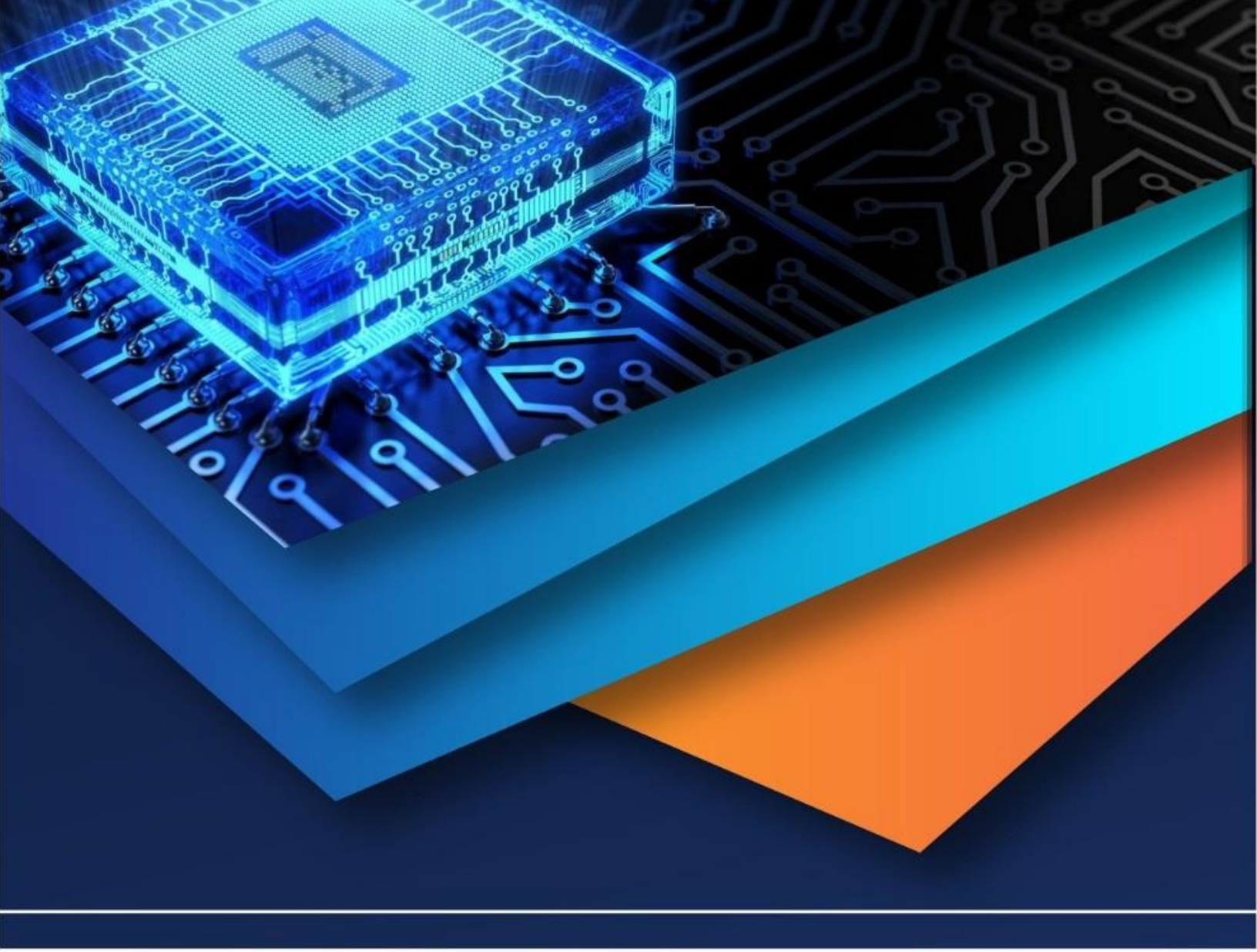
3) Materials has major impact in the project it must be given utmost importance for procuring those materials.

4) Material Resource Planning should be followed on a day to day basis. And the material cost can be forecasted and ordered accordingly.

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