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Construction Material Management on Project Sites

Uppari Naveen Kumar[1], Harish Nayak[2]
[1]*P.G STUDENT, Department of Civil Engineering, shrishridisai institute of science and engineering, Anathapuramu, Andhra Pradesh, India*
[2]*Assistant professor, Department of civil engineering, Shrishridisai institute of science and engineering, Anathapuramu, Andhra Pradesh, India*

***Abstract:** Construction industry deserves the second largest one in India. The infrastructure growth of a country depends on the development of construction industry since it teems with ample employment potential. Implementation of infrastructure projects are usually failing in each stage and ultimately failure occur, which leads to cost and time overrun. The innovation of new technology in the construction field is not being adopted in project implementation. So the growth of construction industry is slow.*

The real problem is construction become difficult since it will not complete with in the budget cost and time and finally leads to project failure as end result. There are many reasons for project failure and some of them are project specific. Studies have indicated that materials constitute about 60% of the total project cost, and control 80% of the project schedule. Hence material has a dominating role in construction. If the material has controlled dynamically the total project cost would be reduced. In this regard, a research methodology has developed to control the material procurement and carrying cost. The methodology adopted has been validated by a computer program and same is found correct and useful for analysis and controlling any type of projects.

This paper is written to fill a void created by the absence of proper materials management on construction sites. To managing a productive and cost efficient site efficient material management is very essential. Therefore the proper management of this single largest component can improve the productivity and cost efficiency of a project and help ensure its timely completion. One of the major problems in delaying construction projects is poor materials and equipment management. Effective management of materials represents an area great potential for improving productivity of work and also controlling cost.

***Keywords:** About five key words in alphabetical order, separated by comma*

I. INTRODUCTION

Material management is an approach for planning, organizing, and controlling all those activities principally concerned with the flow of materials into an organization. The goal of material management is to ensure that construction materials are available at their point of use when needed. The material management system attempts to ensure that the right quality and quantity of materials are appropriately selected, purchased, delivered and handled on site in a timely manner and at a reasonable cost. Material management is the system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost and most importantly are available at the point of use when required. Thus Materials management is an important element in project management.

1) Material is considered as a most valuable ingredient for any project.
2) This accounts for 60-80% of the total project cost. Material represent a major expense in construction, so minimizing procurement costs improves opportunities for reducing the overall project costs.
3) Poor material management can result in increased costs during construction. Efficient management of materials can result in substantial savings in project costs.

If materials are purchased too early, capital may be held up and interest charges incurred on the excess inventory of materials. Materials may deteriorate during storage or get stolen unless special care is taken. Delays and extras expenses may be incurred if materials required for particular activities are unavailable. Ensuring a timely flow of materials is an important concern of material management. For effectively managing and controlling materials, the performance of materials management should be measured.

4) A performance measure calculates the effective working of a function. These performance measures may differ from system to system.

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5) The measures divide the material management system in parts and make the working of the system more efficient.
6) When joined, the measures make the complete material management system. Material management functions include planning and taking off materials, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory and material distribution.
7) Materials management can only produce what it should with the right quantities of the right material at the right time. Thus, any improper handling and managing of materials will cause a huge effect on the total project cost, time and quality.
8) Procurement of materials balances between the Engineering and successful Construction of the project.

II. LITERATURE REVIEW

Material management can be defined as a process that coordinates planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling of materials, minimizing the wastage and optimizing the profitability by reducing cost of material. Building materials account for 60 to 70 percent of direct cost of a project or a facility, the remaining 30 to 40 percent being the labor cost.

1) Neeraj et.al.[2010] has expressed that approximately 42% of Indian government-funded construction projects are facing time overruns. In an earlier study conducted by one of the authors, a second-stage questionnaire survey based on these factors was used to identify the significant schedule performance factors.
2) Heon [2011] has stated construction scheduling techniques often generate schedules that cause undesirable fluctuations in resource utilization levels and unintended peak resource demands that exceed availability limits. On the other hand, resource allocation or resource constrained scheduling models are designed to resolve resource conflicts by rescheduling project activities while minimizing the extension in project duration.
3) Fan [2011] states that scheduling delay is a common worldwide phenomenon in construction projects.
4) Hegazy and Menesi (2008) found that scheduling delays occurred in 70%, 40% and 50% of government contracted construction projects in the United Kingdom, India and United Arab Emirates (UAE) respectively.
5) Anderson [2005] has commented the research focused on engineering projects, typically complex and large in size since they are through likely to offer more comprehensive coverage and evidence of project management practices that can be transferred to smaller projects.
6) Ibbs [2007] expressed that project delays caused damages to direct and indirect cost. Most of the previous research is based on construction projects in developed countries. In recent years, the Indian construction industry has witnessed the arrival of impending projects related to infrastructure development, airport expansion, metro rail, and power sectors.
7) Hisham [2010] Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive material inventory on-site Deficiencies in the supply and flow of construction material were often cited as major causes of productivity degradation and financial losses Efficient planning of materials procurement and storage on construction sites can lead to significant improvements in construction productivity and project profitability The objective of this paper is to present the development of a construction logistics planning (CLP) model that is capable of integrating and optimizing critical planning decisions of material procurement and material storage on construction sites.
8) Said et.al. [2011] explained that Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive material inventory on-site.
9) Guo, [2011] states that the effective implementation of LCM in construction projects relies strongly on a visual communication and collaboration information platform, as information sharing is the key to implementing LCM An effective information platform is needed to gather project information
10) Orabi, et. al [2010] states that the main purpose of this model is to allocate limited reconstruction resources to competing recovery projects in order to generate a recovery schedule for the damaged civil infrastructure system.

III. PROCESS OF MATERIAL MANAGEMET

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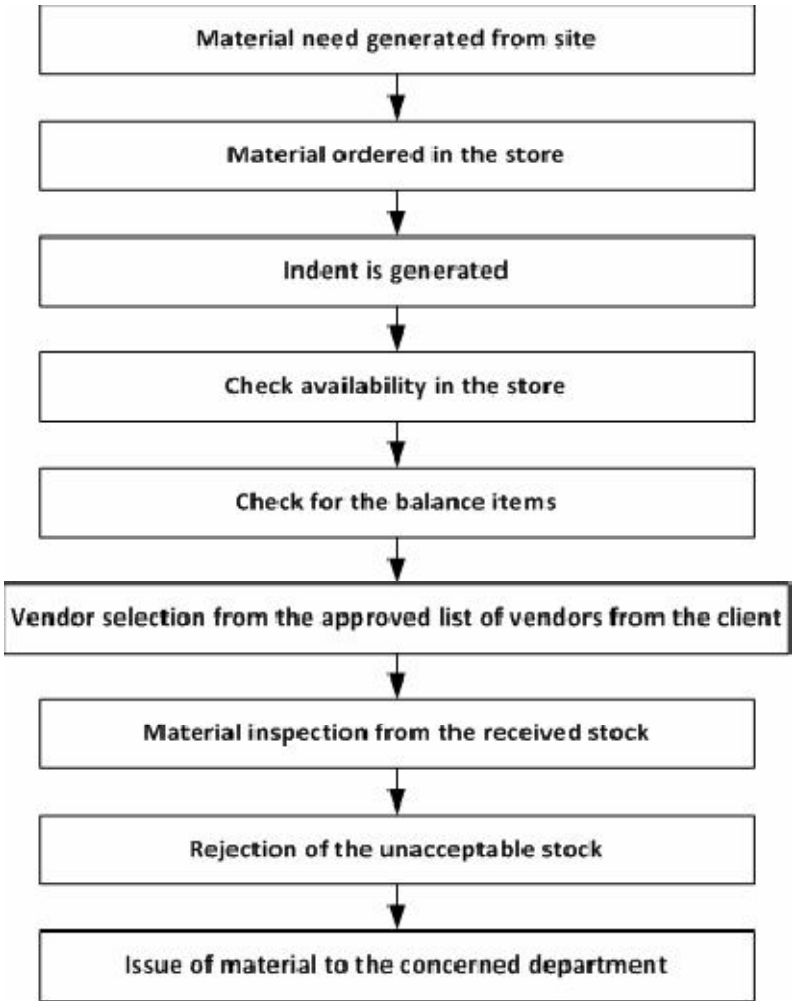


Fig.3.1 Flow chart of material management process.

A. Characteristics Of Material Management

While site material management is normally only responsible for the warehousing, receiving, distribution and the field material control functions, a working knowledge of other functions is essential to the success of the overall project effort. The following listing of nine material management functions gives their key characteristics in effective frame.

1) Planning And Communications

a) Senior management involvement to ensure organizational involvement.
b) Project procedure prepared
c) Formal training and education programs conducted for users and materials management personnel
d) Materials plan prepared for each project and Post project reviews used
e) Master codes and specifications used
f) Material control systems exist
g) Owner's and contractor's senior management are promptly informed of materials progress and problems
h) Internal meetings held to improve communications
i) Owner and contractor aware of restrictions on materials management effort
j) Materials management functions are integrated between owner, design engineer and contractor

2) Material Requirement And Engineering Interface

a) Material requirements identified early
b) Master specification automatically merged with project requirements
c) Bills of materials prepared and computerized

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d) Bulk materials linked to equipment requirements
e) Timely, electronic transmission of data

3) Vendor Enquiry And Evaluation
a) Formal procedures used for screening vendors
b) Coordinated procedure for evaluating vendor proposals
c) Vendor performance monitored
d) Commitments and schedule requirements computerized
e) Use of quality evaluation on vendors

4) Purchasing
a) Purchasing data fully integrated into materials management system
b) Purchase order data automatically transferred from requisitions
c) Purchase orders adapt easily to change
d) Status of purchase orders reported
e) Prevention of duplication of purchases
f) Purchases of critical items tracked
5) Quality Assurance And Quality Control
a) Quality requirements in specifications
b) Project specifications include physical inspection
c) Vendors responsible for quality control
d) Quality plan and quality assurance manual exist
e) Nonconforming materials rejected prior to shipment
f) Positive material identification established in materials management systems
6) Expediting And Shipping
a) Priorities of expediting are pre-established
b) Frequency of expediting and reporting in timely manner established
c) Expediting information exchanged with managers
d) Vendor's schedule matched to project schedule
e) Traffic plans include alternative modes
7) Warehousing, Receiving And Distribution
a) Field materials operations actively supervised and physically secured in order to maintain accurate inventory
b) Warehouse storage lay down area plan established
c) Materials individually protected to meet quality assurance requirements
d) Receiving data entered into system when it happens
e) Shortage and damage reported
f) Warehouse central inventory data maintained, including locations.
8) Field Material Control
a) Material control integrated with other project control systems
b) Priorities of material allocation are adjusted to work priority established by each craft discipline
c) Material control system provide history and status
d) Shortages and surpluses are forecast
e) Shortages are acted upon promptly
f) Receiving, distribution and issue data entered
g) Crafts plan material requirements well in advance
h) Warehouse requests checked promptly to see if valid
i) Periodic inventories conducted and inventory data adjusted with provisions for audit trail.
9) Computer System
a) Computer system provide flexibility to tailor system for each project's requirements
b) Computer system provides current, timely information

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c) Information updated and examined at line item level
d) Data terminals conveniently located in the field and home offices
e) Integrity of system maintained for accuracy and auditability.

B. Objectives Of Material Management

The main objectives of material management are as follows:

1) Efficient material planning.
2) Buying or Purchasing.
3) Procuring and receiving.
4) Storing and inventory control.
5) Supply and distribution of material.
6) Quality assurance.
7) Good supplier and customer relationship.
8) Improved departmental efficiency.
9) Reduce Time Spent at Every Stage.
10) Value Addition at Every Stage.
11) Assure quality materials are on hand when and where required.
12) Obtain the best value for purchased materials.

To fulfill all these objectives, it is necessary to establish harmony and good co-ordination between all the employees of material management department and this department should have good co-ordination with the other departments of the organization to serve all production centers.

C. Functions Of Material Management

The functions of material management are discussed below:

In order to fulfill the objectives of material management as stated above to meet the basic objectives and goals, the functions of the material management are also categorized as primary and secondary functions.

1) Primary Functions

The primary functions of the material management are given as follows:

a) Material Requirement Planning (MRP)
b) Purchasing
c) Inventory Planning and Control
d) Ascertaining and Maintaining the Flow and Supply of Materials
e) Quality Control of Materials
f) Departmental Efficiency

2) Secondary Functions

a) Standardization and Simplification
b) Make and Buy Decisions
c) Coding and Classification of Materials
d) Forecasting and Planning

IV. FIGURES AND TABLES

A. Benchmarking Processes

The process of finding the best available product features, processes & services and using them as a standard for improving a company's own products, processes & services is known as benchmarking process. Benchmarking processes and techniques can be applied to develop Benchmarks for wastage control of building materials. After selection of project, the following steps are adopted.

1) Planning
2) Purchasing
3) Receiving
4) Inspection
5) Stacking & Storage

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6) Issuing material
7) Inventory control.

Work out estimates of quantities of materials required either from the first or final drawings. From site records/ accounts records, actual quantities of material consumed is obtained. Interviews are held with project managers and owners concerned to collect other related information.

B. Planning

Construction industry is a project-based industry where each project is unique. This uniqueness has directly influence over the utilization of on-site logistics and material handling. Each project therefore requires a logistical solution customized to fit project operations. Logistics that are not sufficient or planned improperly can cause additional costs to the project. Time that is consumed waiting for supplies, large redundant orders of material and defective storage of material are some problems that can be traced due to insufficient logistics. In a construction housing project, 28% of the total cost can be traced to material purchasing, while 12% of the total cost can be traced to transportation, machinery and moving material on side. Researches that have been held on the construction industry have shown that 30-35%of all construction cost in a project is a waste. This paper evaluates these problems and their reasons firstly by conducting a research in literature. Thereafter, it analyses the benefits and the implications of purchasing either the exact or bigger quantity of material than what initially is estimated consumption in a project. Furthermore, proposals are formulated about how to develop the logistics on site in order to operate smoothly and subsequently reduce waste.

Material planning includes planning purchasing work, supply planning, and how material handling should be carried out at the construction site. Due to the fact that material costs make up a large part of the total production cost, well-built and functioning routines are essential for good management of material issues. Material planning parts are mutually dependent. It is important to already when planning purchasing starts to determine how the material should be delivered and how it should be handled when it is used. The result of the purchase planning and delivery planning are summarized in the purchasing plan and delivery plan. These two differ, where purchasing plan is a compilation of all purchases to be made while the delivery plan is available for each material and where each delivery are declared.

C. Purchasing

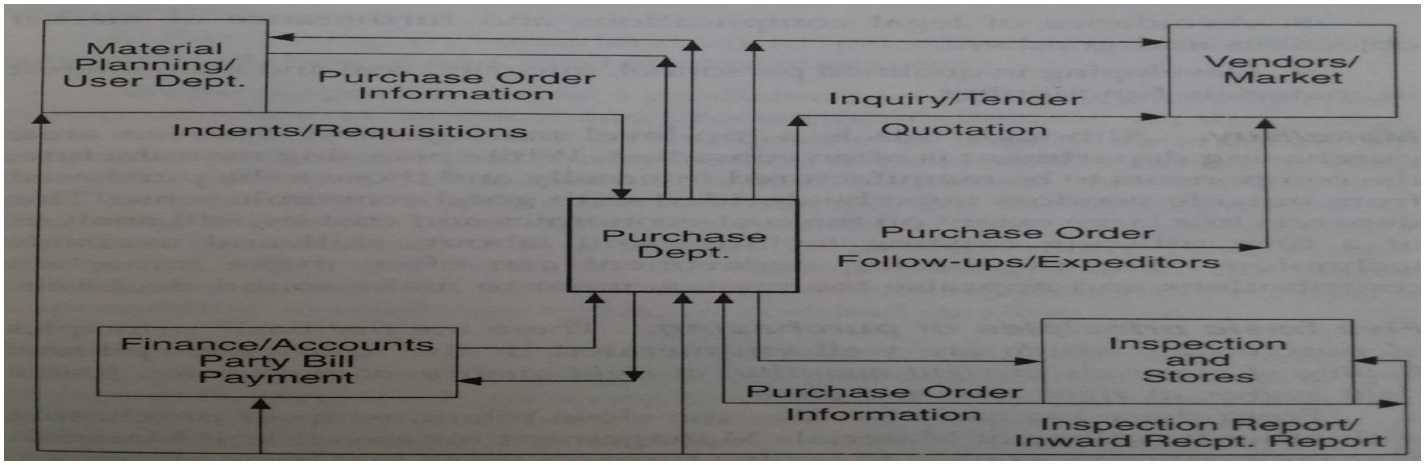
Purchasing implies act of exchange goods and services for money, whereas procurement is a generic term with wider connotation for the total responsibility of acquiring goods and services. Purchased parts and materials have to be planned, procured and delivered when needed. The real problem, however, is to determine the inventory level which ensures a high rate of return on invested capital as well as satisfy the demands of operating and user departments.

Material management is always concerned with economic decision problems where there are two opposite forces at work. Often two different kinds of costs will have to be balanced, one against the other, if a particular problem is to be solved. Materials and supplies are purchased or procured for use in other departments and purchasing department's role is to satisfy their needs within the framework of organizational policy, procedures and objectives. It is primarily service function, through the modern concept is that its role should be to coordinate one with other phases of the material management operations so as to best serve the common goal. This is quite in consonance with the material management concept, since it stresses the service aspects and recognizes its contributions and also gives due weightage to the improved performance and methods for implementation of material management policies of the organization. Therefore, Purchasing is deeply involved in the management of materials flow right from the outside sources down to production through to the inventory pipeline.

Purchasing is both a science and an art. It is a science because there are certain basic principles of purchasing. The application of these principles, when put into practice, makes the art of purchasing an interesting job. Every purchaser should, therefore, acquaint himself with these basic principles and apply them to his job.

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The general routine procedure can be seen from the purchasing flow chart as given in fig. below



D. Receiving

The receipt system can be divided into:

1) Receipt from outside suppliers.

2) Receipts from internal divisions.

System of receipt starts even before the material reaches the site. The three documents that should be dispatched are copy of purchase order, supplier's advice document and the consignment note. This enables the Stores manager to organize and plan for clearances of materials. For receipt from internal divisions, usually transfer notes and return to stores documents are used.

Following Checks are required while receiving a Consignment

3) Name of the Consignor and Consignee.

4) Particulars of the materials receipt.

5) Particulars of Consignment Number:

RR Number: Railway receipt.
AWB: Air way bill.
HAWB Number: House Air way bill.
BOL: Bill of Landing.
HBOL: House Bill of Landing.
BOE: Bill of Entry.

6) Documents pertaining to Excise duty / Customs duty / Taxes and octroi / chungi.

7) Any demurrage claimed or charged

8) Arrangement for physical inspection prior to unloading the materials to identify any physical damage to the goods

9) Any additional charges claimed by the transporter

10) Particulars of packing slip and delivery challan.

11) Particulars of inspection document or to be inspected at site and Insurance Certificate, if insured

12) Tally the documents with Purchase Order / Work Order and Indent

13) If it is equipment supply, then whether it carries product manual, drawings, spares etc. along with the consignment

14) Guarantee / Warranty certificate, internal test and inspection certificate etc.

15) Invoice: a list of goods sent or services provided, with a statement of the sum due for these.

a) Discrepancies And Their Settlement Rejection Of Materials Due To Non-Conformity With The Purchase Order Specification

i. If the materials supplied by the supplier are not found, as per the specification contained in the purchase order, they are liable to be rejected during the process of inspection. If advance payment is not made to the supplier through banks, such rejected goods shall be sent to them as per their dispatch advice.

ii. Excess supplies over the ordered quantity may also be returned back to the supplier, if we do not require this excess quantity. ±5% variation as per provision of Purchase Management System Manual shall be accepted without any amendment to the Purchase Order.

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iii. However if excess quantity beyond the above limits also needs to be accepted, the indenting department shall raise the Purchase Requisition and Purchase Section shall release covering Purchase Order/Amendment.

iv. Till such time regularizing Purchasing order/ Amendment is not received the excess supplies shall remain provisionally rejected.

v. In case payment is made to the supplier through bank, rejected materials may be returned to them after receipt of replacement supplies, through the carrier advised by the supplier, securely packed on freight to pay basis.

vi. Sometime rejected goods may otherwise be usable by the buyer although they are not strictly as the ordered specifications, and as such these may be accepted, in exceptional cases and/or due to urgency of requirements, at a suitably discounted price.

E. Quality And Inspection

1) Significance Of Quality

a) Today, most industrialists are following the motto: 'Manufacturing and marketing of goods/Services of the highest quality at reduced cost.' Quality control principles aided by statistical techniques, aim at improving the product quality and decreasing' the production cost by concentrating on high standards of quality and controls which ensure that the standards are always maintained

b) Quality control techniques are based on the principle that quality should be built into the product and it cannot be inspected into the item. It aims at detecting defects at inception and not at the inspection stage. The word quality denotes the quality characteristics involving the measured and attributes types. Examples of measured characteristics include height, weight, thickness, diameter, volume, fuel consumption, stores consumption, yield per cent, etc. Examples of attribute characteristics include number of defects per item, defective pieces, number of blow holes in a casting, number of mistakes in a typed sheet etc. wherein we classify the item as good or bad.

V. CONCLUSION

A conclusion section must be included and should indicate clearly the advantages, limitations, and possible applications of the paper. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

VI. ACKNOWLEDGEMENTS

An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

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A reference list MUST be included using the following information as a guide. Only cited text references are included. Each reference is referred to in the text by a number enclosed in a square bracket (i.e., [3]). References must be numbered and ordered according to where they are first mentioned in the paper, NOT alphabetically.

Examples follow: Journal Papers

[1] M Ozaki, Y. Adachi, Y. Iwahori, and N. Ishii, Application of fuzzy theory to writer recognition of Chinese characters, International Journal of Modelling and Simulation, 18(2), 1998, 112-116.

Note that the journal title, volume number and issue number are set in italics.

Books:

[2] R.E. Moore, Interval analysis (Englewood Cliffs, NJ: Prentice-Hall, 1966).

Note that the title of the book is in lower case letters and italicized. There is no comma following the title. Place of publication and publisher are given.

Chapters in Books:

[3] P.O. Bishop, Neurophysiology of binocular vision, in J. Houseman (Ed.), Handbook of physiology, 4 (New York: Springer-Verlag, 1970) 342-366.

Note that the place of publication, publisher, and year of publication are enclosed in brackets. Editor of book is listed before book title.

Theses:

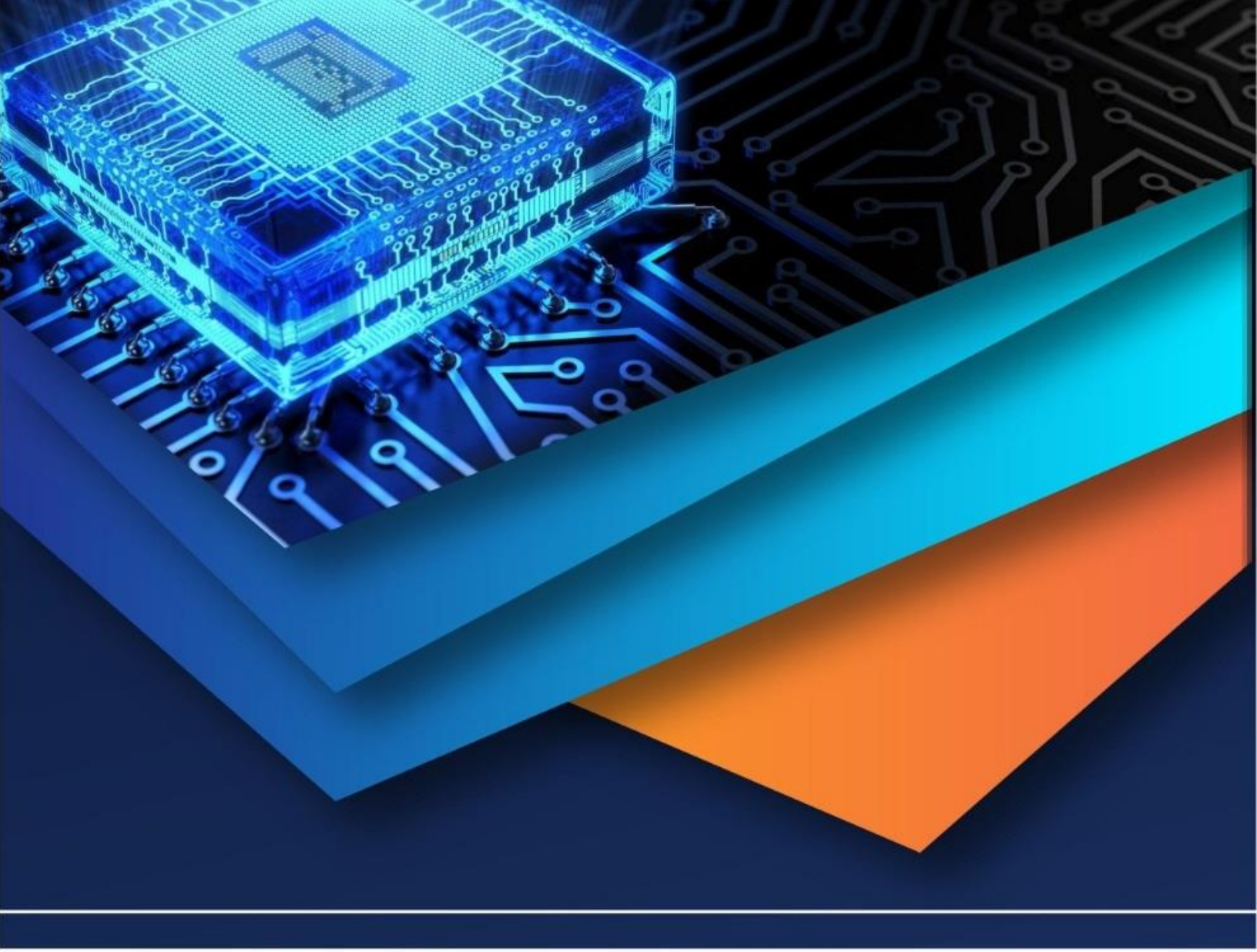
[4] D.S. Chan, Theory and implementation of multidimensional discrete systems for signal processing, doctoral diss., Massachusetts Institute of Technology, Cambridge, MA, 1978.

Note that thesis title is set in italics and the university that granted the degree is listed along with location information

Proceedings Papers:

[5] W.J. Book, Modelling design and control of flexible manipulator arms: A tutorial review, Proc. 29th IEEE Conf. on Decision and Control, San Francisco, CA, 1990, 500-506

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