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A Review of BIM based Inventory Management Workflow and Techniques

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Abstract - **The main objective of material management is to strategically plan the usage of materials, which is crucial for the construction sector. When producing material managing with the goal of fulfilling the demands of production and building. Materials should be kept to a minimum, and the amount of capital should be decreased. in order to choose the best manufacturing scenario and manage the inventory efficiently. In this situation, simulation offers a suitable method for quickly testing suggested scenarios. Building information modelling (BIM) offers a practical and comprehensive way of exchanging data among various contexts, which is necessary for simulation models. Thus, the information extrapolated from the BIM model is used in this study to propose a mix of discrete-event and continuous simulation that simplifies inventory management for large scale construction. This strategy creates a schedule and guarantees consistency and efficiency of the workflow. This research will provide a brief overview of the inventory management process in order to give some insight into why these techniques are so necessary. We'll also talk about various ways that inventories can be managed and review some of the popular BIM-based RDBMS systems (Relational Database Management System) on the market. The compression of different types of inventory management workflow concludes that a more efficient work process, increased activity, and less input time and burden compared to a management system without BIM. These results showed that construction project management performed better under the suggested BIM-based approach.**
Keywords: **BIM Technology, Inventory Management Workflow, Inventory Turnover Times, Construction**

I. INTRODUCTION

Inventories are the actual supplies of things or material that a project/construction manager or association keeps close by for effective construction works at site. Inventory Models essentially deals with the materials and its procurement. This models also helps in material management in order to store the materials for subsequent use. The materials account for more than 60% of the total cost, therefore any savings from inventory can have a significant impact on the final project cost. The comprehensive process of creating and managing information for a built object is known as building information modelling (BIM). BIM creates a digital representation of an asset throughout its existence, from planning and design to building and operations, based on an intelligent model and made possible by a cloud platform. The implementation of a BIM-based strategy for inventory management is a new approach to company planning and development. It enables employees to execute difficult tasks utilising operational data from previously completed days of work that was recorded through the use of software programmes. Architecture is one such application which can be used to visualize the process on any particular project site, making it easier for those involved in planning to understand what is going on around them, who is working where, how much time different activities have taken place over a period of time, and so on.

Coordination is the primary focus of the construction industry, and it is something that the design, owner, and construction units all engage in. However, when the project experiences implementation issues, it is necessary to gather the necessary personnel to hold a coordination meeting to identify the root causes of the construction issues and identify potential solutions, after which appropriate corrective actions for the construction changes must be taken. The coordinated solution does, however, lag somewhat. There are a number of knowledge collision issues since there may be communication issues during the project's creation. For instance, because the construction drawings differ, there may be conflicts between the structural design of the beam and the pipeline layout in the actual construction of HVAC and other specialties. This type of issue is frequently encountered in daily construction, but it can only be resolved once the issue manifests itself. BIM building information models may coordinate the early-stage collision problems of different disciplines, create, and give coordination data, which can effectively handle this problem. In addition to facilitating the collision of several disciplines, the coordination function of BIM technology also significantly advances the layout of elevator shafts, fire compartments, and subterranean drainage systems.

Through BIM, we can create a virtual model of a Building and also do the real time monitoring with the material requirement in each phase. So, the application of inventory management techniques along with BIM technology, may give effective control on inventory and there by its cost. The traditional inventory control technique is a three-period balance sheet system, which defines one period as current, one period as the ending balance sheet of current year and other period as end of previous year's balance. Inventory

value is calculated by multiplying quantity with price. This simple technique helps a company track what has been spent in different periods with same accuracy. A construction company needs to maintain its inventory in order to be able to manage the cost by maintaining the quantity and quality of resources. There are various techniques that management companies use in order to control their portfolio.

An overview of the construction industry's challenges and what it is looking for, an overview of various approaches to inventory management and their advantages, advantages over traditional ways, possible limitations that come with this way of managing the inventory and a case study example. A detailed explanation about what RFID (Radio Frequency Identification) technology is, how it works along with its benefits and disadvantages over other technologies available now like barcode scanning or web-based applications for a more efficient system for production tracking.

A. Objectives of the Study

Lake of Coordination between stakeholders and vendors regarding Material Procurement of Construction Material. The size of Inventory is also an important aspect which should be taken care of, so to decrease the indirect cost of store. Inefficient planning and scheduling & less use of BIM technology in India is one of the aspects of cost overrun in material management. Reviewing and analysis of previous workflow of Inventory Management. On-site Store Management and Material management in Construction Industry. A case example is given in the literature review. I see a huge scope of saving the resources, which includes money, time and also reduces waste which ultimately helps in increasing sustainability aspects of the surroundings, optimization of all the resources and improvement in triple constraints is the solution which will be concluded in this paper.

II. LITERATURE REVIEW

A. Inventory Management Workflow Based on IoT and Cloud Computing Method

The authors (Rajesh Bose, Haraprasad Mondal B., Indranil Sarkar, Sandip Roy) use this model to suggest a unique strategy and demonstrate how it might assist the construction industry in managing inventories of crucial formwork shuttering goods. The research's backdrop is tied to Indian construction enterprises, but the findings can be applied to other geographical areas as well.

The authors of this study suggest a model that is divided into two components. The embedded bar code scanner is highlighted in the first section, while data processing and transmission to cloud-based applications are shown in the second. They have provided a quick overview of the many processes that are involved in our proposed solution in the following subsections. The entire piece has been shown in workflow diagram in figure.

The authors have detailed how the suggested web application is accessed in this section to maintain the smart inventory management system. The application displays a login page where the user must provide valid information. After entering the needed data on this page, authentication and authorization are carried out. After successful user authentication, barcodes are created in the following stage after GRN entries have been made for the site's formwork shuttering components. Although the number of reports offered in our suggested inventory management system for formwork shuttering components is undoubtedly not large, the two taken together promise to offer significant insights into the inventory-readiness of formwork shuttering components, whether in the form of items that have been specially resized to meet project-specific design requirements or those that have been designed to the manufacturer's specifications. These technique combines three crucial areas to provide an integrated method for enhancing the management and oversight of formwork shuttering components. "Researchers' studies have already shown that computerised inventory management solutions that rely on barcodes, RFID, or NFC are incomparably superior to manual and or traditional systems of maintaining raw material inventories and making them available for use in the construction industry. The application of formwork shuttering components is essentially unique. Components have a limited amount of reusability, much like any other raw material or enabling item. These can, however, be chopped and resized, resulting in entirely different specifications from the original item. Not in terms of difficulty of computation, but in terms of calculating area based on dimensions and taking into account the manufacturer's original code indicating size and form, the calculations necessary for such scaled shuttering components provide a challenge.

Our proposed solution includes a component that has been designed to handle the issues of calculation, re-identification, and barcode labelling. This component is the web-based interface application that enables users to access data using a smartphone, laptop, or PC from anywhere over the Internet. We have presented an Arduino-based barcode sensing Internet of Things system because keeping track of objects in a construction zone is undoubtedly a difficult chore. For inventory or production purposes, these embedded Arduino-based devices can be used to swiftly scan formwork shuttering components. We suggest that these fixed installations with Arduino-based devices be placed at various vantage points throughout the project site in order to satisfy practical concerns and for better outcomes. This would free up workers' time so they could swiftly scan barcodes into the system and process shuttering components rather than spending extra time recording the consumption of such at a single pre-determined site that might be some distance from the real work area.

Future work on our suggested architecture might profit from our investigation into the use of barcode sensors and Arduino-based microcontrollers in an unusual IoT-based strategy. We chose 1D barcodes in part because of their

affordability, simplicity, and durability. Although RFID and NFC remain viable alternatives and, in certain situations, the first choice of many researchers, it sis vital that economic factors be maintained in mind while conducting research. Furthermore, our suggested web application design can serve as a foundation for more complex web applications that incorporate a range of reports generated with the aid of machine learning and artificial intelligence.

B. Inventory Management Workflow through Central Simulation Engine (CSE)

The majority of off-site construction activities, especially panelised construction, are completed at the plant, where components are created before being sent to the job site for assembly. This method separates the two main phases of construction geographically, thus close coordination is necessary to prevent delays that result in budget and schedule overruns.

C. Central Simulation Engine (CSE)

The CSE is divided into four smaller modules, each of which is in charge of handling a specific stage of building. Both internally and externally with the other model elements, the sub-modules communicate with one another. Moreover, depending on the pattern or scenario that the team is testing, the sub-modules can operate interactively or independently. This enables the user to investigate a range of options to identify the ideal pattern.

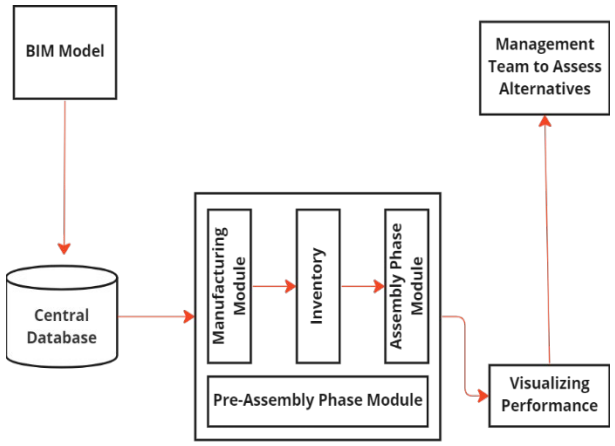

Fig. 1 Central Simulation Engine (CSE)

The inventory module tracks the behaviour of the inventory utilized during building using continuous simulation. The movement of panels into and out of the inventory is simulated by the CSE's simplest module. It is in charge of producing performance reports and sending them to the analysis unit for analysis and decision-making.

The generic model discussed in this work facilitates the importing of many building types, provided that they have been accurately modelled in the BIM environment. In order to help the management team, select the best production pattern and the ideal inventory quantity and prevent financial losses, it also offers a variety of visualisation techniques. Additionally, because the system integrates all phases of construction, it is feasible to plan the project so as to limit overproduction, which can result in factory shutdowns, or underproduction, which can result in delays during on-site assembly. The absence of a Graphic User Interface (GUI) on this system, however, makes it less user-friendly for people who are unfamiliar with the simulation platform that was used to develop the CSE. Additionally, the modules are manually fed the distribution functions needed for the probabilistic simulation. As was already indicated, the BIM model must be created in accordance with standards that the CSE can understand, which restricts the framework's capacity to support all BIM models uniformly. Further research will be focused on refining this aspect and enhancing element recognition so the model may ingest data from the BIM model independently of the modelling standards used to generate it. The model's inference engine needs some intelligence.

D. Comparison between Traditional and BIM Based Inventory Management System in Prefabricated Construction

In this paper Author talks about the prefabricated building material management technique based on BIM technology reduces turnover times to 3 and the traditional method to 2.

As can be observed, the management of prefabricated building materials based on BIM Technology may reduce capital consumption and warehouse occupancy rate higher than the traditional way while simultaneously improving material quality control. With the aid of BIM technology, we are able to prevent issues with prefabricated building construction, such as "mistakes, omissions, collisions, and shortages," achieve integrated collaborative management from prefabrication to operation and maintenance, and significantly raise the general standard of prefabricated building construction and management. The use of BIM Technology in prefabricated buildings still faces several challenges, including faulty technical standards and a lack of industry acceptance. It needs to be further developed in practice in order to accomplish the seamless integration of BIM Technology with prefabricated buildings.

E. Procurement Difference between the Two Technologies

The ability to utilise enterprise surplus cash as efficiently as possible while providing for daily material demands is determined by the inventory turnover rate. High inventory turnover rates can decrease the accumulation of materials as well as the rate at which funds are used. The material turnover times of the prefabricated building material management method based on BIM Technology are higher than those of the conventional prefabricated building material management method, and the data is shown in Figure. This is because BIM Technology can make the purchasing personnel know the materials and quantity needed by each production department and construction part in time.

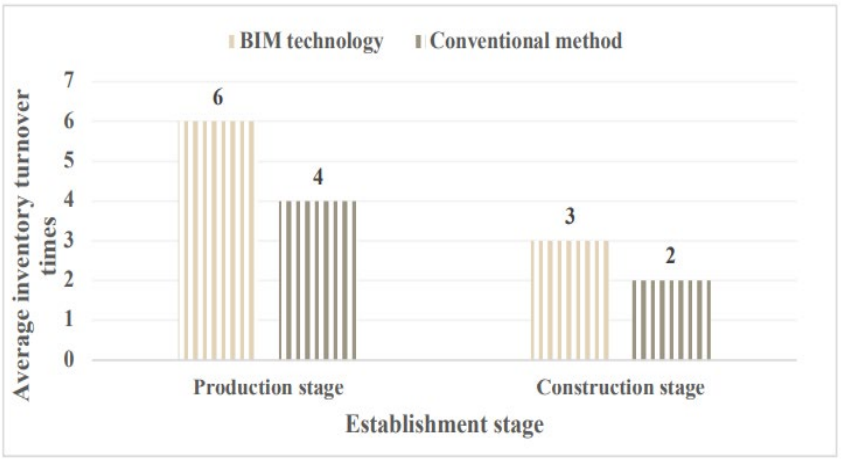

Fig. 2 Turnover Time Comparison Graph

F. Comparison between Transportation Cost

The problem of increased transportation costs is caused by the prefabricated construction materials management method's high inventory turnover rates.

On the one hand, longer travel times, higher fuel costs, and an increase in the loss of fixed assets like materials and cars. On the other hand, the cash discount or commercial discount offered will rise if the total amount of each purchase is high. As a result, the typical approach can inadvertently lower the overall cost in this case. Table I displays the specific transit cost. The typical inventory turnover. Construction phase Production phase timing implementation of BIM technologies traditional approach.

TABLE I EXPENSES OF TRANSPORTATION

Methods	Unit Price per Purchase	Transportation Times
BIM Technology	5.32	15
Conventional Method	5.11	12

According to Table I, the cost per unit of the prefabricated building using the BIM technology-based material management approach is greater than the cost per unit for the prefabricated structure using the conventional method. The conventional technique is superior in terms of transportation costs since the prefabricated building material management system based on BIM Technology requires three times as much transportation time as the traditional way.

G. Differences in Storage between the Two Technologies, Comparing Warehouse Occupancy

The warehouse's occupancy rate and price are strongly related. The low warehouse occupancy rate can result in less use of the space and lower warehouse rent for the development project. The above material turnover periods show that the prefabricated building material management technique, which is based on BIM technology, has a fast material turnover rate, which results in a low warehouse occupancy rate. Figure 3 illustrates a comparison of the two construction techniques' warehouse occupancy rates.

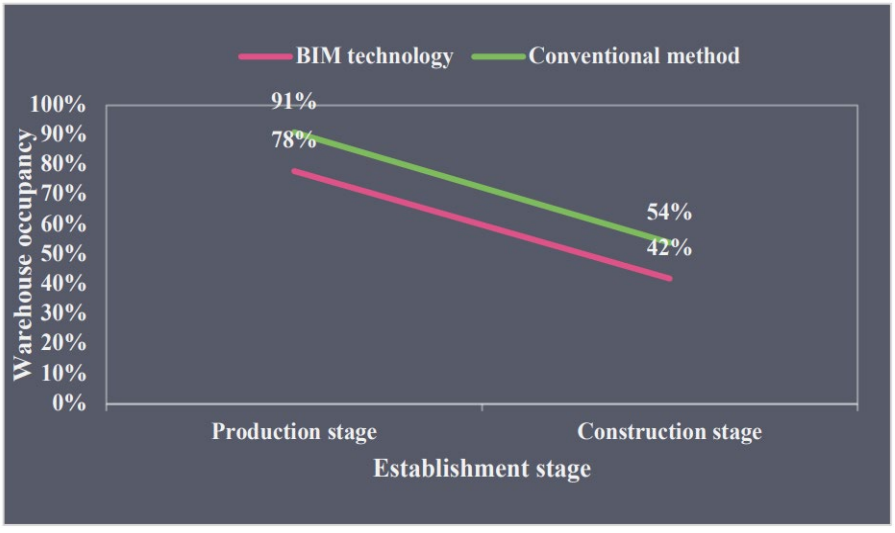

Fig. 3 Storage Occupancy

A comparison of the warehouse occupancy rates for two different building methodologies Figure shows that, regardless of whether it is in the manufacturing stage or the construction stage, the warehouse occupancy rate of the prefabricated building material management system based on BIM Technology is 78% and 42% lower than that of the conventional method.

III. METHODOLOGY

Study first collected the materials like literature review and latest published papers related to inventory and material management, then a case study of a live construction project and circulate a survey form to the experts related to the field, and then draw the conclusion from the analysis of the case study and survey results.

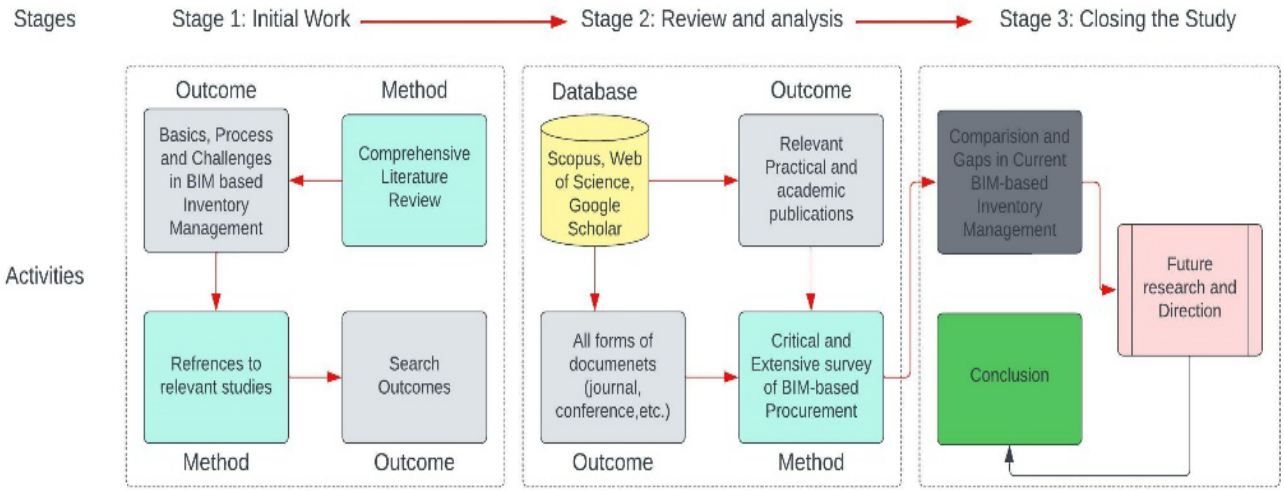

Fig. 4 Overview of Research Approach

IV. RESULTS AND DISCUSSION

Through the detailed analysis of the two methods, the results show that the proportion of surplus useless materials in the warehouse of BIM Technology in the production stage and construction stage is 6% and 3% respectively, while that of the conventional method in the production stage and construction stage is 4% and 2% respectively. Therefore, intelligent logistics under BIM is not only accurate in life, but also can save time and effort. However, in the future, the development of intelligent logistics technology still needs a lot of research and technology promotion. The transformation of traditional small workshop factory logistics management mode is imminent. The development of intelligent logistics needs the support of computer system and information flow, it is necessary to design the organization structure, production process and process mode reasonably.

A. Inferences

The traditional method of material management primarily relies on the use of forklift trucks combined with manual scheduling, necessitating the participation of several manual workers who are unable to assist in the input of information, the operation of equipment, inspection, or detection. The majority of them continue to operate on paper. The process sheet in the conventional foundry facility is susceptible to contamination or damage throughout the process transfer project, leading to unclear identification. It is challenging to enter and change a variety of processing parameters at the same time. The workpiece and the process sheet might not match. Data collection, input, sorting, and analysis are almost often done manually, which can easily lead to information delay and distortion. One of the buildings completely implements BIM technology, whereas the other structure uses conventional construction techniques and makes no use of any auxiliary technology. The management of materials using traditional methods and the management of materials using BIM technology are then compared and studied.

V. CONCLUSION

This study discovered that the intelligent logistics management system based on BIM Technology responds more quickly than traditional logistics management, saving time, money, and decreasing error brought on by human error. Additionally, this article examines the management of materials during the construction process, visual statistical analysis of construction materials, and dynamic management of construction materials based on the BIM practise. The establishment of the project collaborative management system, which offers more logical and effective conditions for the continual development of material management, is based on the real-time monitoring of supply and demand. Materials are produced as needed for the project's on-site construction management, order delays are avoided, delivery efficiency is increased, visual dynamic management is realised, the construction plan is optimised, progress and cost control are more effectively managed, and the project's quality construction management is encouraged.

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