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Utilizing Chat GPT for Automation of Material Supply in Construction Projects using Programming and Primavera P6 Scheduling

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ABSTRACT. *Construction Industry (CI) is considered as the backbone of a country's economy. Despite the fact, it experiences high fragmentation and reduced productivity, delays, cost overruns and lack of innovation from the start till the end of a project. It has been identified that material deliveries often affect productivity at site therefore this study focuses on the development of Automated Materials Supply (AMS). Supply chain in construction being automated presents a feasible solution to late material deliveries and cost and time overruns on a project by proposing a framework for information transfer by using primavera schedule and OPEN AI among stakeholders of the project to avoid material overruns on-site and reducing human effort. The result of this study leads to the development of a framework that executes the information transfer among various stakeholders of a project to automate the material delivery process.*

Keywords: Automation in Construction, Supply Chain, Programming, Open AI.

1. INTRODUCTION

Construction Industry (CI) is important in the economy of any country and also contributes 6 to 8 percent to global GDP. Not only this, Construction industry also generates revenue for other industries like manufacturing industry [1]. Having such an important role of CI, its productivity is a major concern. Coordination involves integration of different parts of numerous organizations. Supply chain Management being the other one is a major responsible factor contributing to the delay or success of a project [2]. Tragically, productivity in construction is a major issue and various factors have been identified that results in low productivity e:g "Late material delivery" , "Delay in providing information to contractor" , "Poor skills of labor" , and "Inadequate planning and management of construction supply chain". Productivity problems in CI needs to be focused and requires solution [3]. The building and construction industry is gradually embracing new technologies like Digital Twin, BIM, AI, IoTs etc. to enhance the effectiveness, output, precision, and safety of constructed environments. The Industry 4.0, targets conventional industry practices and production techniques and transforms into intelligent systems using digital technologies[4]. Therefore, to identify reasons for late material delivery on site and which stakeholder causes this problem and results in poor productivity of the project this research will be conducted and necessary recommendations based upon the results will be given.

1.1 Materials Related Problems

Problems regarding material management have been identified and are categorized as (i) problems associated with purchase and material supply – This category encompasses the planning of material delivery any discrepancies in the orders placed and the materials delivered on site. (ii) Logistics Related Issues, it includes auditing materials on site, observe the transportation and distribution of materials throughout the site and issues with the supply and acquisition of the materials [5]. Logistical problems also include work stoppages and abrupt orders, these not only increase the cost but also delays the project if material is not delivered on time.

2. LITERATURE REVIEW

Due to its complexity, the Construction Industry is highly vulnerable to a range of unpredictable factors that can impact its performance. Every industry is shifting to digitalization and so is Construction Industry (CI). Although it has been observed that CI lags in this area of development as compared to other industries. However, CI is reshaping itself in regard to automation in every domain of planning, supply chain and logistics, construction, operation, and maintenance (O&M) [6]. Among all these, supply chain and logistics greatly impact the productivity of CI. Logistics involves movement of goods from supplier to consumer in a cost-effective way. Construction site logistics include coordination between site and suppliers by incorporating their decisions and interdependencies so that supply chain cost is optimized. Some contractors uses construction logistics management due to its benefits regarding material supply and site activities [7]. Hisham Said created an automated system for optimizing logistics to aid contractors in planning and coordinating material supply and site-related activities[8]. This automated-system is named as AMCLOS that worked in 5 modules that helped in performing tasks of (i) acquiring (ii) storing (iii) processing to generate and optimized logistical schedule

Any Construction project can be regarded as a sequence of macro-phases like Engineering, Procurement, Construction etc. Therefore, management as well as integration of any two phases of these projects is very crucial to deliver the project in an effective way. F Carom and G Marchet have developed a stochastic model for planning the material delivery on building site to ensure the highest productivity of Construction process by over-viewing the optimum amount of material to be made available on site so that desired level of progress is made. This model can be used even at planning stages of the project [9]. It evaluates the required quantity of material on site and delivery date until which it should be delivered at site.

The Construction Industry is predominantly characterized by fragmentation, which results in reduced productivity, as well as cost and time overruns, and disagreements among different stakeholders. Coordination is the main problem in the Construction Supply Chain. Coordination can be defined as integration of people within an organization or between different organizations for accomplishing some set of goals for mutual benefits [10]. Coordination is the main issue that causes the delays in projects leading towards cost and time overruns and thus producing conflicts among the parties of a project. Xiaolong Zue and Xiaodong Li analyzed a problem in construction supply chain that was majorly focused on coordination and hence developed a framework for integrating construction organizations in a Construction supply chain over the internet [11]. Being the first trial, some errors were found in this model which were rectified later, and the findings came out to be useful as it reduced the time due to miscoordination and enhanced response of suppliers.

Every Construction site is known for its stockpiles of materials and equipment as they are the most important for the execution phase of the construction and without them construction is not even possible [5]. While maintaining these stockpiles can be costly for contractors, it is still more economical than the potential costs they may face if they run out of materials during execution or experience a breakdown in the construction supply network. To address these issues, Duncan A. Young proposed a solution that integrates material locating technologies with Construction Supply Networks. This solution involves using a modeling and simulation report to monitor on-site materials and keep it up-to-date. By implementing this model, uncertainties within the construction supply chain can be reduced, and it can provide estimates for schedule improvements[12].

As every project in Construction Industry requires client's demand to be sufficiently met within the allocated budget and time therefore, there is a huge pressure on the supply chain networks and personnel to give their maximum output so that project outcomes are met on time by their timely input. So, in the current era of technology and digitalization, digital technologies are being implemented in the Construction Supply Chain and Procurement processes to facilitate innovation. Walid Elmughrabi used two-echelon Supply Chain that included a manufacturer, warehouse and multiple sites where multiple projects are being executed. He used a model with collaboration between contractors and suppliers made possible [13]. This helped in finding sequences in which construction projects should be executed and accordingly the sequence of material ordering and manufacturing and also proposes inventories plan for supply chain managers.

By reviewing literature, it has been observed that late on-site material delivery results due to ineffective construction supply chain and coordination issues which further effects overall performance of the project and for improving project's performance different technologies were implemented, barriers in adoption to those technologies were identified and barriers that those technologies results on-site were also identified, AR was implemented in the construction phase of project and frameworks were developed to enhance the collaboration among stakeholders. Critical planning decision making framework of material supply to site and storage was also developed but there is still a need to develop some framework that can automate material orders and material delivery on site by critically reviewing the project progress through schedule and automate the Supply Chain procedures so that project's performance can be maintained. The objectives of the paper is to present a framework on minimizing the delay factor that results due to miscommunication on-site activities.

3. METHODOLOGY

The literature review and field research have revealed that in the majority of instances, inadequate control and management of materials result in problems with material management, delays in project advancement, and consequent escalation of expenses. Materials are a crucial part of any project's cost, so every attempt should be made to make material management effective. A model for material ordering and monitoring has been created (as shown in Figure 1), which is automated. The model involves purchasing materials, keeping a track on orders, documenting data about materials when they are received, and monitoring their movement on the construction site.

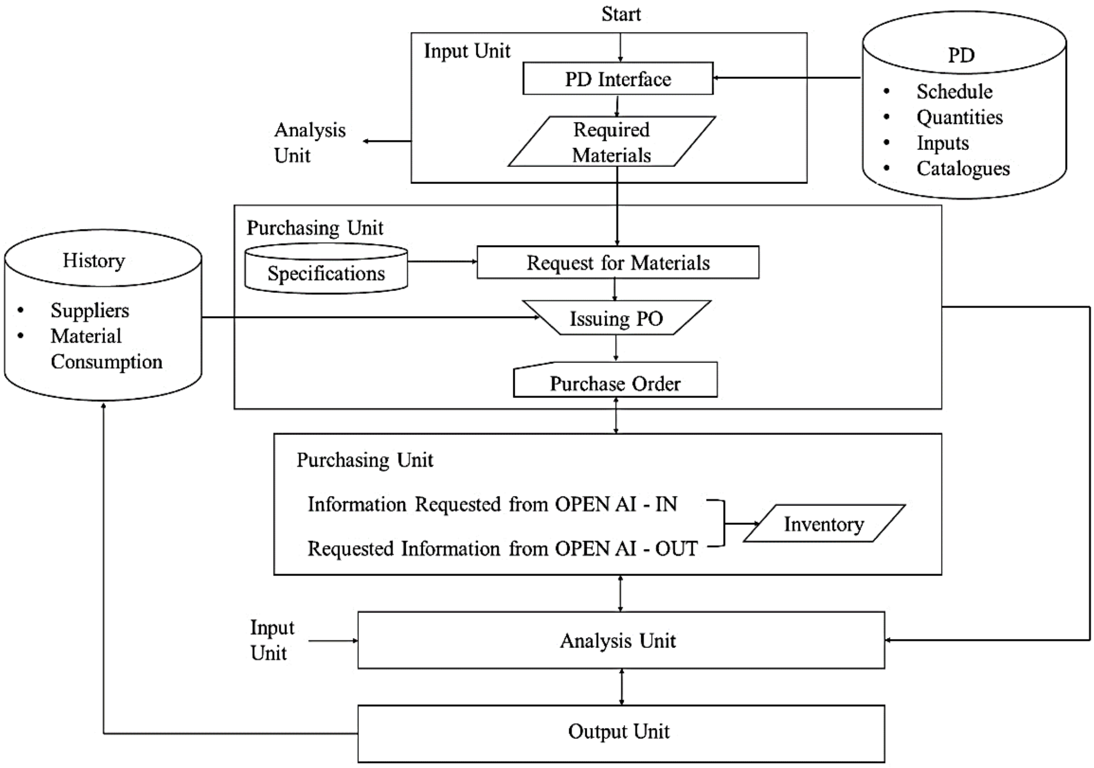

Fig -1: Proposed System Architecture

The framework consists of five parts (1) Input Unit, (2) Purchasing Unit, (3) Tracking Unit. The Input Unit uses data from Building Information Model (BIM). The system extracts information from project schedules, planned quantities, deadlines, and other key information for each activity from the BIM. For the effective operation of this framework, schedules should be kept up to date. Database will be automatically updated every time schedule is modified or a change order is issues.

The Input Unit, at intervals, estimates the required material for both ongoing and future activities by updating the schedule. Ongoing activities are defined as those that are currently in progress and whose predecessors have been fully completed or are scheduled to begin on the earliest possible date. The outcome of this step is documented in the Required Materials file that contains information such as the activity's duration, material quantities, and the expected time of material delivery.

Using the details from the Required Materials file, Specifications, and on-site material inventory, the Purchasing Unit decides which materials to order or introduce if necessary. The Input Unit anticipates and saves the materials required for these tasks in the Required Materials file. It then generates a Purchase Order using information from the Supplier's database and details provided by the Required Materials file, as well as any information requested or newly introduced materials. Purchase Order is issued by keeping track of lead times, inventory capacity and necessary material required. It can be integrated with an Open AI platform like ChatGPT to find concerned vendors. Draft purchase orders and issue them thus reducing effort to develop a Purchase Order for every material individually and Tracking unit keeps a track of the materials being sent out and used at the site.

Upon arrival of material on-site as per the date their amount and specifications are compared with the issued Purchase Orders and accepted or rejected accordingly. If all the requirements of the PO's are fulfilled, materials are accepted and kept in inventory after proper record. Automated Data Collection (ADC) technologies like barcodes and RFID help in collecting information regarding material arrival and usage. The Unit investigates the dead and rolling. The Investigation Unit gets information from the Buying and from the Following Unit and produces the information for the Result Unit. Recommendations are made by the unit by using a comparison of planned and actual material quantities. Table 1 shows various parameters that are calculated or compared by the proposed system.

Table-1: Parameters compared or calculated by the system.

Parameters	Description
Quantities planned versus ordered.	This keeps an eye on how the Purchasing Unit works, checking to see if all of the required materials were ordered and in the right quantities as per planned quantities. This comparison is important because issuing a Purchase order involves manual process that can result in errors.
Planned vs. used quantities	This is essential for planning, scheduling and estimating for future purposes.
Ordered vs. used quantities.	This data keeps the record that how much material is used of what was ordered.

3. CONCLUSIONS

Effective material management and control is a fundamental strategy for any construction project. Currently, the Construction Industry is facing challenges such as high material waste, slow work progress, and cost overruns due to mismanagement and inefficient control of materials. To address these issues, an automated materials supply and management framework has been developed. The framework involves purchasing, analyzing, and monitoring the materials, providing feedback on the order progress, on-site material delivery, on-site material movement, material consumption, and other related matters. The study has concluded that utilizing the framework offers several benefits, including increased and on-time delivery of materials on-site, enhanced productivity, access to accurate and reliable data on the stock of available materials on-site, reduced material waste and inventory levels, and improved data control for more accurate future planning.

By using schedules of projects, OPEN AI and programming a framework was developed that could be implemented on a construction project for automating its material supply. Different types of data were entered and results were seen by automating different supplies of materials for a small scale project. Future studies may try to implement this framework on a real life project and calculate the cost and time effect it incurs on the project as compared to traditional material supply method.

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