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Influence of technologies like BIM, SAP and other tools for enhancement of quality and productivity of the organization based on lean manufacturing techniques

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ABSTRACT

Armed with technologies from Building Information Modeling (BIM) to IoT, contractors are well trained to translate the construction information into operational insights. Using Lean Manufacturing Techniques there are innumerable opportunities to streamline the business process in construction. SAP provides smart technology-enabled workforce across contractors and employees. SAP eliminates the downtime waiting for materials and reduces cost. This paper discusses the role of BIM and SAP tools which ultimately optimize for the continuous innovation in the quality and productivity of the organization. These tools provide an excellent platform for professionals to work in the highly integrated environment at any stage of complete building delivery process. BIM is linked to ERP which provides visual component through the entire process and helps to minimize errors. These innovation tools integrate business transaction and analytics to digital core making everything simpler, faster and smarter.

Keywords: *BIM, Operational insights, Lean Manufacturing Techniques, Optimize*

1. INTRODUCTION

1.1. Lean Manufacturing in India

India is a promising manufacturing destination and most of the industries prefer to seek ways to stand out in their manufacturing capabilities in the market by eliminating wasteful activities from the system. Lean Manufacturing is one of the best approaches that Indian industries are currently looking forth to be more competitive in both the global and local market. In India, Construction industry is the second largest industry after agriculture [1]. It involves a broad spectrum of construction: Infrastructure – Highways, Airports, Seaports, Railway Stations; Commercial – Offices, Shopping Malls, Multiplex Theatres, Hotels; Residential – Apartments, Single Family Houses; Institutional – Schools, Colleges, Hospitals and Industrial – Warehouses, Refineries, Mills, Industrial Plants, Factories. Construction accounts for around 65% of total investment in the infrastructure. Over the next few years, the construction sector is likely to be the biggest beneficiary in infrastructure. Nine variables are recognized in lean manufacturing, namely: JIT deliveries, the elimination of wastes, zero defects, continuous improvement, decentralization, multifunctional teams, pull of materials, integration of the functions and the vertical information systems.

Toyota Production System (TPS) forms the foundation of lean manufacturing was developed in the 1940s in Japan by Ohno and Shingo. Toyota focused on minimizing waste in operation by utilizing many techniques and tools including Kaizen, poka-yoke, cellular manufacturing, etc. Toyota is capable enough to make higher quality cars with a very small number of defects resulting in better customer satisfaction. Lean manufacturing is considered as a new paradigm that completely eliminates waste anywhere anytime and any form persistently strives to keep up harmony in materials and information and constantly attempts to gain perfection. Lean production, an assembly line methodology was being developed initially by Toyota and by other manufacturing companies. It is commonly known as the Toyota Production System or the just-in-time production. Lean manufacturing (lean enterprise, lean production or simply, "Lean") is basically the production practice considering the expenditure of the resources rather than the creation of value for the end consumers and ends up in the target of elimination. Lean management has allowed these enterprises to offer a highly diversified range of products, at the lowest cost, with a high level of productivity, the speed of delivery, minimum stock levels, and optimum quality.

10. LITERATURE REVIEW

As to our knowledge, there is no comprehensive overview of recent research of BIM for existing buildings; we partly try to close this gap with the contribution at hand. The objective of this paper is to examine BIM in a broader sense, as depicted in Figure 1 [2], BIM functionalities exist in buildings as well as the dependencies between organizational, information and technical issues of the BIM model. Multidisciplinary or, specific research gaps are discussed and identified.

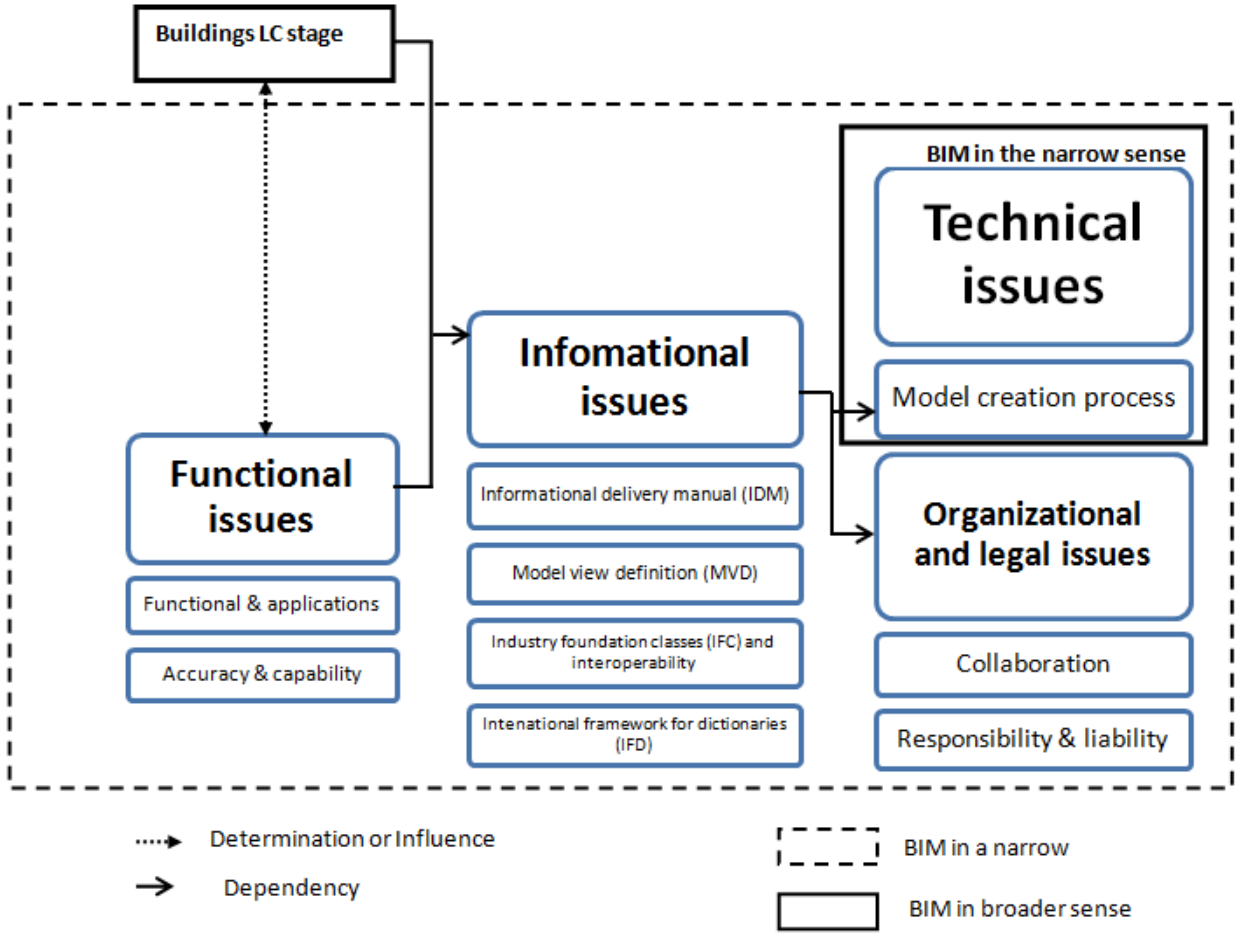

Fig. 1: Relation between the building lifecycle stage (LC) stage as well as the technical, functional and organizational issue of BIM

Management who are involved in construction, architecture, and engineering has been enhancing knowledge about BIM in the last few years. This knowledge is more likely to result in increasing the technology in Construction Industry which helps in using BIM predicting the unfavorable events. Safety, health, construction intersects with BIM in terms of the applicability which is highly important in the technology.65% of construction workers accidents can be managed and controlled by utilizing 4D BIM. Additionally, the manner in which work is conducted and the safety hazards that exist is now based on BIM in several ways on a large number of projects. In fact, there is increasing attention regarding the use of information technology in general, as well as Specific BIM research for construction safety.

Acceptance of company resource planning systems by small manufacturing companies have specified in their studies that limited research has been done to understand the acceptance of ERP systems by small companies as compared to the bigger companies[4]. Therefore to avoid this gap they consider the strategic, business, technical and human factors that influence the acceptance of ERP systems in small manufacturing companies. They provide a consultative list of acceptance factors in the research, which is used in the future.

"Managing Business with SAP: Planning, Implementation, and Evaluation" This book deals with an overview of the various parameters for the successful implementation of the SAP as ERP application[5]. The book has three major sections. In the first section formation of SAP and ERP technology is described. The second part deals with the evolution of SAP since 1972. Then the third section explains how academicians are able to get proper knowledge of the SAP R/3 system into the graduate and undergraduate college course.

11. BUILDING INFORMATION MODELING (BIM)

BIM is basically a virtual model of any building that comprehends clear-cut geometry and data for receiving procurement, optimum design, construction and fabrication activities required for the project. This finally improves the overall efficiency, optimize resources and enhance passive design strategies. AEC industry has adopted numerous techniques to increase the quality, productivity, reduce project delivery time and optimize the project cost. BIM helps to manage data in a model platform which enables the user to visualize and define the connection between location, geographical information, material of objects and buildings, structural analysis for building, drawings of high accuracy, helps in detecting flaws between various BIM models, highly user friendly wherein the users frame their own rule set of model.

BIM is acting as a platform to exchange the data between BIM and various software of ERP system develops plug-ins in different programming languages like Python and C#. This facilitates the exchange of data between BIM software using the normal BIM Industry Foundation Classes (IFC). BIM provides complete visualization during the whole life cycle process and provides an exclusive feel for the final product once the construction is done. To meet the target visualization of the building, BIM software

assists the client to take a decision regarding materials and geometric information accurately. BIM allows creating the object model of ceilings, stairs, walls which integrates the design and realization of the construction process in improving the quality and productivity. BIM model can be augmented, synthesized, published with schedule and cost information. With the help of BIM, contractors and building owners can improve predictability, optimize schedules, reduce risk, collaborate efficiently and manage the cost of the projects associated with buildings. According to the lean production management, these attributes also present the elimination of waste as well. Fig 2 establishes the design and realization scheme of the prefabricated construction through lean production.

The use of BIM technology in the construction projects not only improve the construction process but also enhance the quality process by making a good interaction with the participants of the team members[6]. BIM incorporates the geometry, building components, spatial relationship, quantities and its properties [6]. BIM maintain and generates the information produced during the life cycle of the project- from design to maintenance which can be applied in various fields [7]. The examples of the research work are the integration of safety checking for safety analysis [8], and dynamism of safety management in construction site [9]. BIM is highly beneficial in preparing the schedules, estimates, managing, and tracking required changes and manages site logistics as well [10]. Open communication through the exchange of data and easily verifying the design requirements and analyzing the performance using BIM [11]. Utilization of the BIM model has increased the total project quality [12]. Here the parametric modeling provides excellent tabular views of the components with the elements like attribute, metadata type, relationship [13, 14].

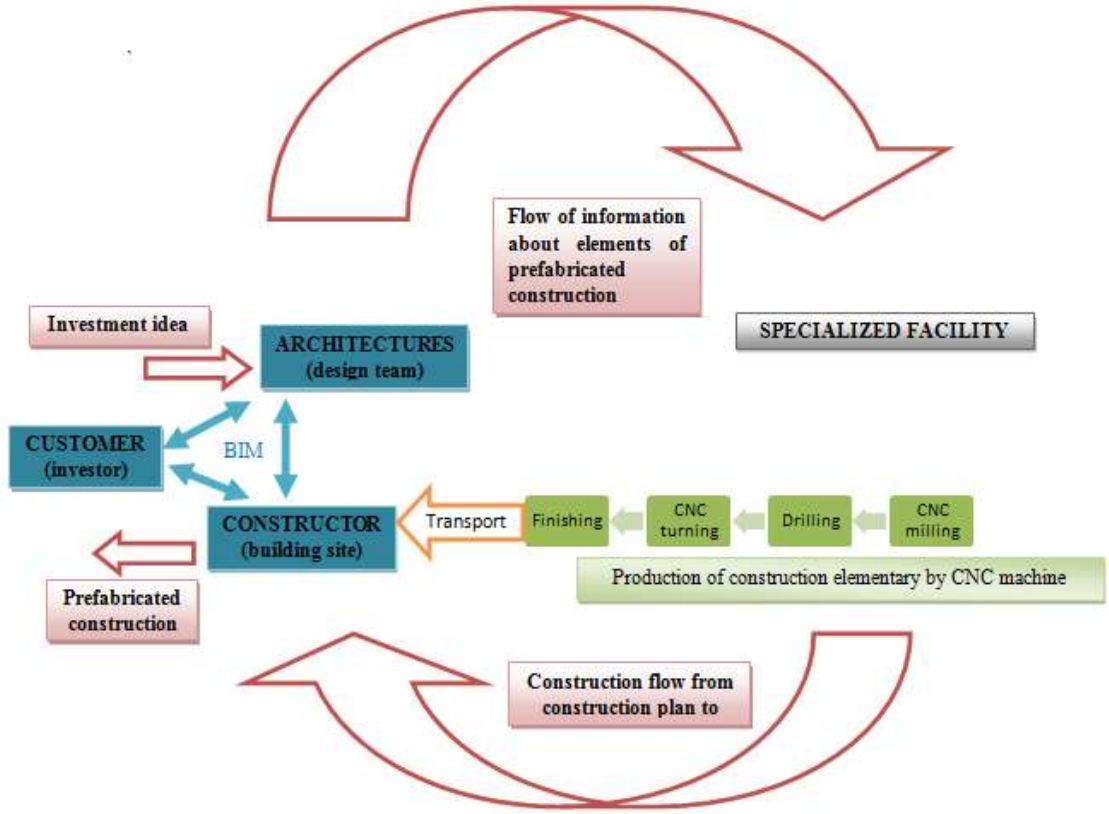

Fig. 2: Design of prefabricated construction through lean production

12. THE RELATION BETWEEN BIM AND QUALITY MANAGEMENT

BIM generates information which is produced in the whole life cycle of building from design to maintenance of estimates and schedule which includes managing site, logistics and tracking can be applied to many fields. BIM has introduced to enhance the overall quality of the product. This improves the venture quality in the following ways:

- Enhancing design assessment, exactness, and proficiency.
- Reduce the error due to good coordination among the entire team and thus minimize the clashes.
- Optimization easily conducts a simulation.
- Eliminate the cost of maintenance and operation.
- Programmed building record produces reliable data.

13. BIM-BASED CONSTRUCTION QUALITY MODEL

BIM-based construction quality model is designed with a combination of the BIM model and POP Model. A sample model is designed to match up the BIM component from BIM. Normally BIM covers only geometric parameters but that's not sufficient to link to the components of inspection lot. Therefore it is necessary to extend quality attributes when updating and creating a model with certain construction methods and material requirements. Hence BIM model is designed with significant quality attributes for specific building element such as construction method and material. The interrelationship and framework is described in Figure 3.

- According to 4D BIM-based construction, appropriate product template for the inspection is being chosen.
- On-time required data is filled in the template.
- Analyzing of data integrity is being carried out for the compliance analysis.
- Providing result for 3D virtualized model with feedback control and schedule adjustment.

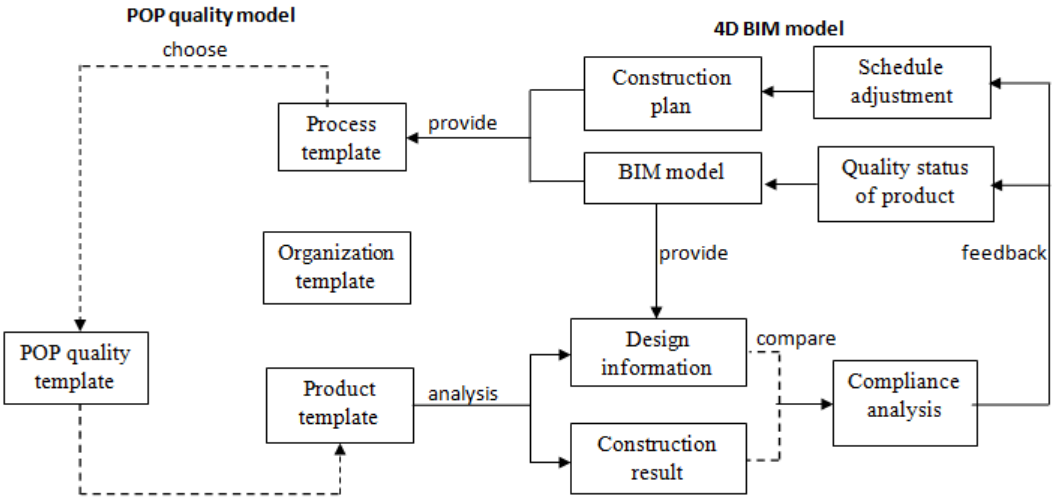

Fig. 3: Framework of the BIM-based construction quality model

14. WORKFLOW IN BIM-BASED CONSTRUCTION QUALITY MODEL

The workflow order is designed as described in the Fig.4.The quality control process initiates with a request for the acceptance after completion of inspection lot. For real-time data analysis which is collected from the construction site is fed into the template. If the inspection lot accepts the inspection, then the project proceeds to a new task, if the NCR report fails, corrective action is issued. Once corrective actions are implemented, the whole process will run again. Finally, the result is visualized in BIM according to the ease of quality managers. Repeating the input again and again for data sharing, analyzing and communication is highly reduced. The on-site information is entered into the BIM-based quality model and it's processed easily. Illustration of quality analysis is done along with the construction progress as per the following analysis,

Logic analysis

According to the sequence of construction, inspection process of construction quality in BIM quality model is designed.

Integrity analysis

To prevent error high data integrity is maintained with BIM quality model, data validation rules will reject incomplete or wrong data.

Deviation Analysis

In this process, actually quality control data is necessarily compared with design data. The design construction code acts as reference data in BM based application. The bio-based quality model compared actual quality testing data.

Compliance analysis

BIM-based quality model is processed in multi-level acceptance sequence. This model does the analysis for quality control item and visualizes whether actual quality test results match up with needs of corresponding codes in quality model.

15. QUALITY STATUS FEEDBACK

The scheduled information is being integrated into the model wherein the status for the construction project is checked. Once the inspection is done, the results are analyzed from the color metaphor or rework order generated. If the lot is accepted, it continues with next process. If the lot fails a non-conformance report is being generated which states the reason of failure or inconsistency in the design code and further construction results are being issued for further corrective action.

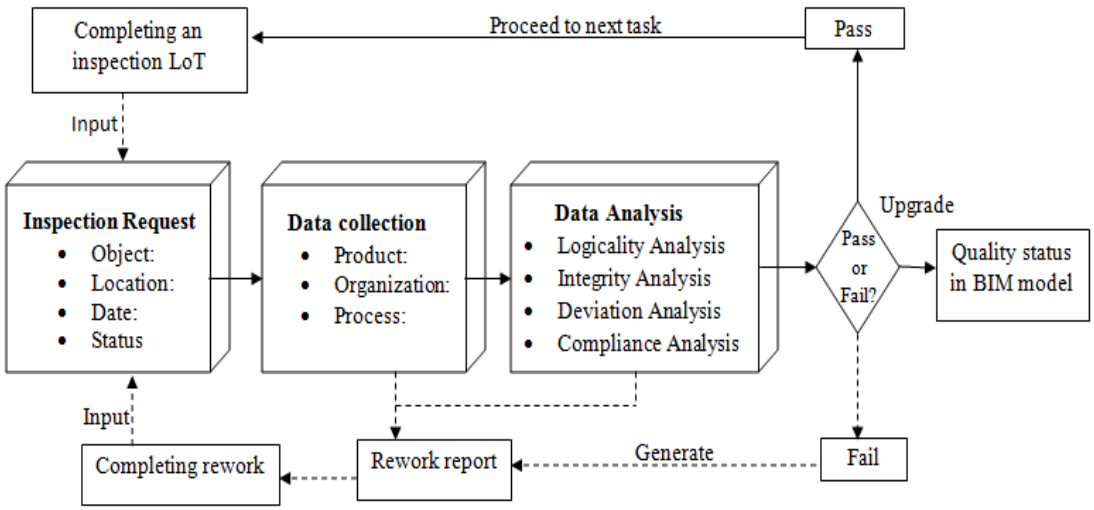

Fig. 4: Workflow of the BIM-based quality model in construction

16. SAP

The SAP is a System Application Products which is highly used and is a proven application of ERP. To enhance the performance of the organization's management control, resource planning and operational control SAP utilizes the highly proficient ERP software. SAP multi-module application software integrates the activities across all functional departments from parts purchasing, product sales and distribution, product planning, plant maintenance, financial and human resource controlling to quality control. Many functions are integrated with the SAP application. SAP integrates multiple business functions and various reports are generated according to the business functions. This helps in taking up operational decisions efficiently. SAP basically works on three functional areas such as Logistics, Finance, and Human resources. In different functional areas, different modules are created in the functional area, which is highly integrated with each other. The elements under the logistics module include:

8.1 Logistics

- Quality Management (QM)
- Material Management (MM)
- Warehouse Management (WM)
- Sales and Distribution (SD)
- Production Planning (PP)
- General Logistics (LO)
- Plant Maintenance (PM)
- Project System (PS)

SAP Module software is the core of an ERP system. Each module automates the business activities within the organization. Generally, the ERP software module includes inventory control, order tracking, accounting, product distribution, human resources, and product planning and finance aspects of an organization. ERP is an integration of various functional departments. The SAP users include employees from various levels in the organization from supervisors, workers, and mid-level managers to the executives.

SAP QM is an important module in SAP that crucially controls the quality of the product. SAP software will help to run the warehouse effectively and ensures that the goods and services are I optimum level. SAP help to enhance and check the quality of the product in the warehouse continuously and effectively. SAP-QM module is an integral part of logistics and supply chain functions which includes Product planning (PP), Material management (MM) and plant maintenance. Quality management is crucial to the warehouse on inspecting the incoming materials as it gradually arrives for the further manufacturing operations, where the quality of the goods to be processed are re-checked before finished goods reach the warehouse, they are totally inspected. QM module of SAP mainly covers three crucial areas- Planning, Inspection, Notification. Quality planning function allows the quality department to plan for the inspections of receipts of products and vendors, stock transfer and work in progress. Quality notification is requested action taken by the quality department. Quality inspection is a kind of physical inspection using the specification defined for quality planning.

8.2 The key benefits of SAP module include

- Customer satisfaction and high product quality
- Quality compliance is cost effective and superior.
- Continuous measurement is taken to improve the quality

SAP quality management ensures that products meet the regulatory standard which is uniform, safe and meets the organization's product specifications. SAP QM process is highly integrated with the manufacturing process. QM module includes all quality management tasks like quality planning, quality control, and quality inspection. The important QM terms under SAP is mentioned here. Fig5 depicts the integration of SAP module with Quality management.

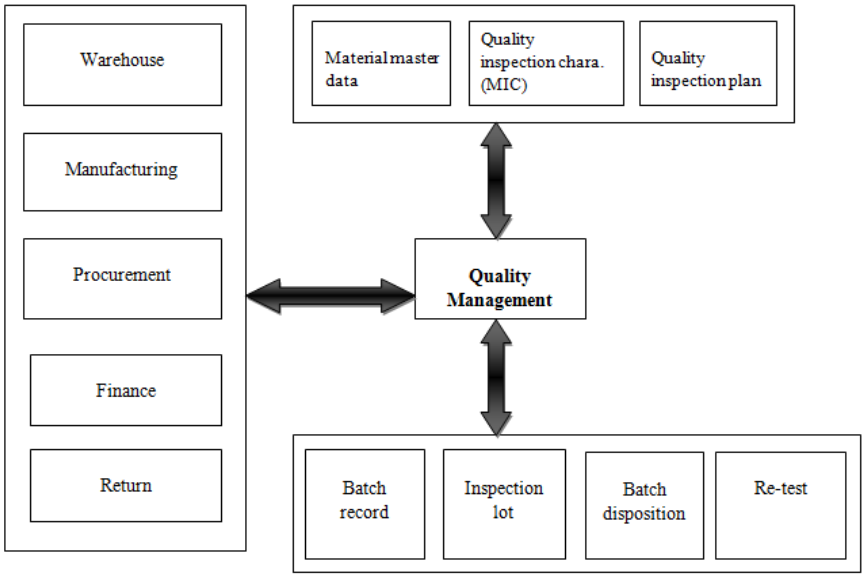

Fig. 5: Integration of SAP modules with quality management

Quality Inspection
This is identification to recognize whether an inspection unit satisfies the specified criteria.

Quality Planning
It includes framing and managing the master data which is required to complete and plan the inspections.

Quality certificate
The documents include value, text, inspection results which certify the material.

Quality notification
The processing and recording of the external/internal problem resulted from the poor quality.

Quality control
The mixture of specifications from the result of the quality inspection, quality notification, and inspection planning

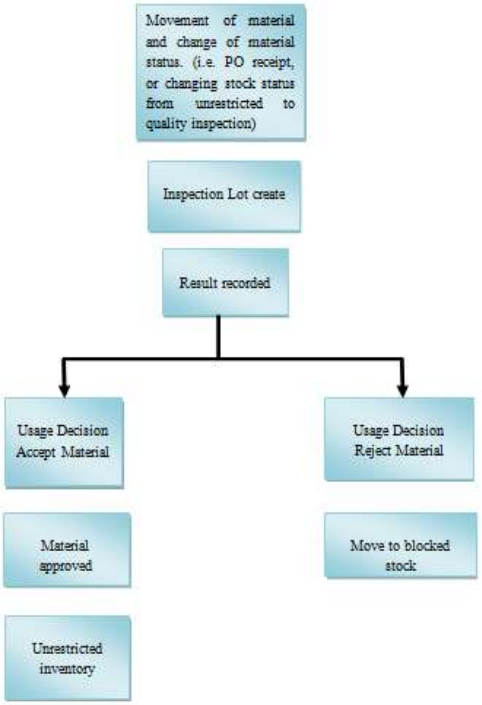

Fig. 6: Typical tasks in quality management

Figure 6 shows the typical task handled in Quality management using SAP –QM module.

17. CONCLUSION

Achievement of quality in the industries have reduced the production cost by debugging cost, re-implementing few rejected works, reduce maintenance costs and hence increasing the labor market share[15]. BIM model is most practical and efficient than the traditional methods as it removes many obstacles which arise during the implementation period as it is verified in the design phase [16]. BIM is usually adopted in the model for being more real-time, appropriate cost, maximize capacity in the field for building and designing three dimensional by the entire modeling process defines the object links[17]. BIM procedures have been creatively developing in building 4D and 5D models as well. Traditional quality management has completely failed to interact dynamically with the design drawings and quality management process. Here in this paper, the BIM model and existing POP model have been together utilized. This paper also describes that how these two models together work to enhance construction quality management. It helps to understand the progress of quality and can be collaborated effectively. The implementation of SAP in the organization in various modules has improvised the functions of all departments. SAP–QM module has been successful in checking the quality of materials which comes in the warehouses and that moves out for delivery. These tools like BIM and SAP have effectively created a great impact in the industries based on lean manufacturing techniques by optimizing the resources, cost and improving the productivity and quality of the organizations.

18. REFERENCES

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