Intelligent Architectural Plan Approval with Digital Twin based live Monitoring using SAP Predictive Engineering Insights and Internet of Things

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***Abstract*–Construction of high-rise buildings, individual houses, shopping malls, hospitals and industrial facility is on the increase. Plan approval is a prerequisite to initiate the construction, but this requires multiple stages of approval and there is no real time mechanism to monitor actual plan after site construction. This leads to illegal encroachment of either private or public property. After construction the house owners, tenants and officials are not aware of the current quality of construction materials inside the building. This probes a high risk during natural calamities, which can create a devastating effect to human life.The current process needs value stream mapping to develop an effective application for a safe and happy living.**

I. INTRODUCTION

In any given country, the public sector, and in particular the national government can enhance competition and productivity by simplifying and harmonizing building codes and standards. By setting and enforcing time limits for construction permits and environmental approvals, governments can greatly reduce project delays. Ideally, governments should also minimize barriers to competition at an international level. Moreover, they should provide appropriate support to academia and companies for developing technological innovations in construction. In addition, the regulatory framework should leave room for technological progress and should anticipate emerging needs. To achieve these objectives, it is crucial to have well-designed building codes and standards, as well as transparent and streamlined permit processes. [1]Considering the magnitude of human loss associated with building collapse and other disaster and the ineffectiveness of the emergency management, there is the need for immediate review of practical policy guidelines by the government that should be carried out to letter to make safe for living. Statutory implementation of all physical development planning regulations, acts, bye-laws and codes in the processing of building permit, actual construction and post occupancy follow-up, prosecution of physical development and planning culprits.[2]Traditionally, building planning has been carried out separately by various planning consultants for mechanical and electrical systems to plumbing, etc. This lack of coordination often results in severe problems during the construction phase. Building Information Modeling (BIM) centers around developing the entire building with all its disciplines first on a computer and then simulating, testing and, if needed, correcting it in a virtual model. Among other things, this planning leads to optimal energy efficiency, cost savings and increased sustainability. Building tenants and occupant no longer just want an attractive, climate-controlled building. Instead, they demand infrastructures that ensure their safety; provide real-time information, guidance and productivity. [3]Digital twins differ from Building Information Modeling (BIM) in that BIM is a process and digital twins are real-time virtual representations. BIM involves the generation and management of digital reproductions of physical and functional characteristics of places, whereas digital twins can serve as repositories of BIM data as well as a much broader array of building automation systems and sensor networks. The data collected for digital twins can come from a variety of sources. A true digital twin must be a "system of systems" integration like embedded sensors, Wireless sensor networks, Digitized building lifecycle data and systems and Integration with other cloud services and data providers. [4] The engineering analysis used in SAP Predictive Engineering Insights is called Finite Element Dynamics in Elastic Mechanisms (FEDEM). It can be used to model, and so monitor, static and flexible structures and moving machinery. [5]SAP Predictive Engineering Insights Enabled by ANSYS, leverages real-time operational data from assets via sensors and engineering simulation models to detect emerging issues, analyze root causes of problems and simulate what-if scenarios.[6]Drone enabled topographical scan system reduces the need for manual survey and the exact location coordinates are captured.[7] [8] [9].SAP has come up with a Cloud Platform for prototyping named BUILD that allows design thinkers to develop intuitive prototypes based on the user story, engage end-users for feedback and jumpstart design ideas.[10]

II. PROBLEM DESCRIPTION

The construction of a domestic or commercial space starts with land survey, design plan, blue printing the final design and approval from government authorities / other local bodies. The overall lead-time for approval depends based on various factors like the type of city, priority of submission and other miscellaneous factors. This process involves a lot of manual effort and there is a high risk on the building design change

and layout encroachment after the approval. The current process lacks mechanism to digitally review, simulate, perform load analysis,compare results, control and approve new building architectural designs. The key consideration after building construction is the safety. The expected life and strength of the building and materials can change depending on various factors. The tenants, owners, visitors and employees are ignorant on the life span of materials used and this probes a threat to people living in such spaces.

III. PROPOSED ARCHITECTURE

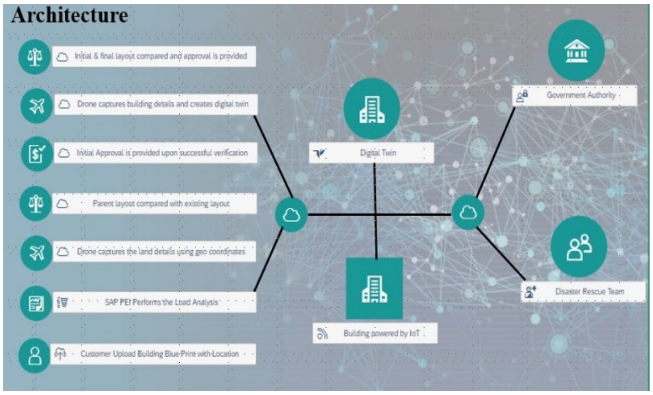

Fig 3.1 Architectural Design

The design comprises of integration of physical assets like drone with a three dimensional scanner with SAP Predictive Engineering Insights software and Internet of Things through the Cloud. The automated process starts with the upload of two-dimensional and three-dimensional blue print images. The new application then distributes this image for further load analysis to understand the maximum load that the building can withstand. A drone also captures the boundary coordinates of the land and compares with the parent layout repository present in the database. Based on successful validation the initial approval is provided in conjugation with the load analysis result. Once the building construction is completed, drone surveys to compare the constructed building withparent layout and initial blue print. The final approval is sanctioned on successful verification. Thecaptured images are to construct the Digital Twin and sensors relay the live information of the building to the monitoring team.

IV. RESULT ANALYSIS AND DISCUSSIONS

The novel application provides customers a new user experience platform. Registered customers and officials have separate login credentials. The main page provides information to the public on the new approval process and a facility to book drones for land survey. The users without any login can upload / edit / view their blue prints for approval based on the geographic locations. Load analysis and resultant heat map diagrams are processed using SAP Predictive Engineering Insights software. The sensor health report and digital twin model provides information on the building and building material robustness. Cloud interface integrates this application to other technologies.

Fig 4.1 Application Main Page

V. CONCLUSION

This paper emphasizes the digital shift in approval process using a new application that will integrate with technologies like Internet of Things and SAP Predictive Engineering Insights to provide a hassle free approval process. The digital twin technology coupled with sensors will ensure regular monitoring of the building health. This real-time data integrates with government websites and disaster rescue team, whichprovides and ensures a safe living space.

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