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APPLICATION OF 6D BIM TOOL FOR CONSTRUCTION MANAGEMENT AND MONITORING

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ABSTRACT:

This project presents application of 6D building information modeling (6D BIM) on a real business-storage building in Slovenia. First, features of building maintenance in general are described according to the current Slovenian legislation, and also a general principle of BIM is given. After that, step-by-step activities for modeling 6D BIM are exposed, namely from Element list for maintenance, determination of their lifetime and service measures, cost analyzing and time analyzing to 6D BIM modelinga comprehensive literature review of the abilities of BIM as facilities management tools, which would be helpful for predicting an accurate performance of the building Facilities management supports operation and maintenance of a building and its services. Facilities management is multi-faceted complex task often challenged by lack of updated information. The implementation of BIM has improvised facilities management tasks by providing relevant information throughout the building lifespan. BIM creates a platform for information exchange between stakeholders of architectural, engineering and construction industries modeling for preconstruction, construction and post construction phases. Then, the project examined the uses and benefits of BIM in the construction of a research facility. Subsequently, a prototype 6D Building Information Model was created and studied. Furthermore, the BIM-based schedule was integrated to the 6D model. Finally, the project concluded with an analysis on the use, advantages and setbacks of BIM and its tools.

I. INTRODUCTION

The life of buildings goes through many phases. The project starts after the recognition of needs for buildings. Upon initiation of the project, which includes feasibility analysis, the project is developed as drawings and specifications or nowadays as a BIM model with additional information. Afterwards, a building is built. By the end of construction works, it is turned over to the owner. A finished building is occupied, maintained, repaired and renewed in its lifecycle. This is the operation time in which the owner is responsible for ensuring the functioning and durability of the building. Since this period involves neither the architect nor the construction professional all the design and technical documentation should be handed over to the owner. In addition, the process to start-up building's active technical systems should be done together with owner's representatives doubtedly, operation and maintenance phase is the longest period in the whole building lifecycle, lasting for many years before a general renovation is needed. Therefore, life time of the building is highly dependent on regular and timely maintenance. Regular maintenance services are important building management functions and the part of the integrated Facility Management (FM). Obviously, the aim of building management is to maintain or even increase the value of the building and is responsible for maintenance functions, comprising the technical management, operation, maintenance, repair, and emergency managementOn the other hand, regular implementation of the maintenance services is related to the applicable legislation. From the technical aspect, Construction defines the term building maintenance, representing execution of works whereby the object is maintained in good condition, and enables its use. Next, it defines the term regular maintenance, representing investment maintenance works, repairs, construction, installation and finishing works and improvements following the progress of technology.

These works should not interfere in the structure of the building or change its intended use.6D BIM is modelled in handing over procedure and intended as a guide with all the necessary information which is given dynamically.

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It serves for organizing smooth functioning of the building and planning measures for maintenance work and renovations over the entire lifetime of the building. One of the most important benefits of 6D BIM is an easy access to the building element databases from which information about producer, type and model of equipment, service intervals, and technical specifications can be accessed at any time. In this way, the building manager manages information and supplements easily, while receiving information material in the traditional FM, such as the as-built drawings, instructions for operation and maintenance, certificates of completion is of static importance.

BIM:

Building Information Modelling (BIM) is a tern that is most generally used to define a set of parametric tools and processes for the creation and maintenance of an integrated collaborative database of multi-dimensional information regarding the design, construction and operations of a building, with the purpose of improving collaboration between stakeholders, which reduces the time needed for documentation of the project and producing more predictable project outcomes. Most of the times people misconceive BIM The most common fault is that they assume that BIM has a single model or database. While this is not even near the case that BIM is used. We have to bear in mind that BIM cannot replace human. BIM diminishes the redundant and mundane works and it facilitates data processing, but here, human individuals put data into the model. Another mistake that is commonly committed is that people assume that BIM has no errors at all, while this is not the case. Because human beings are capable of inserting some data incorrectly, the errors in BIM are probable.

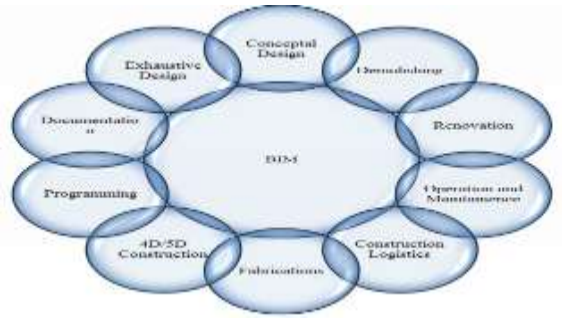

Figure: 1.BIM services in construction industry.

II. METHODOLOGY

To review the geotechnical data integration during pre-construction stage using BIM, three steps were carried out. First step, a comprehensive literature review was conducted to increase the understanding of data integration process during pre-construction phase and the differences between traditional method and BIM-based method. Connecting BIM and pre-construction stage is the main concept of "geotechnical data integration" that which will be discussed Pre-construction is one of the biggest areas of risk and uncertainty in construction project as it deals with subsurface ground conditions information. The amount of detail data needed in pre-construction especially for existing data modelling and site analysis should be sufficient enough to ensure that significant risks could not reasonably be anticipated. Current practicing method in interpreting data during this stage tasks reveal limitation. Construction industry faced many obstacles due to the depends on the traditional practice; paper-based document which missing and redundant data always happened. In recent years, there has been a shift in construction where people move to BIM application because of its potential to reduce the problem faced by infrastructure world. BIM has become a successful technology and widely popular in the construction world especially in developed countries because of its potential. Nowadays, people are moving one step ahead in BIM which is adoption of BIM during pre-construction stage. Thus, this paper review studies centered on BIM-integrated modelling during preconstruction stage. But there is lack of practical researches have been made during this stage. Although a large number of studies on BIM have been conducted in the past decade, a lack of consensus remains among researchers and practitioners regarding the applications of BIM during pre-construction stage, the availability of subsequent data integration tool for geotechnical activity

Feasible Methods to Create a Site-linked 6 D Model:

To create a site-linked BIM model, one needs to first seek for current technology support. As previously stated in this report, there are currently three major software vendors who provide technology resources for this purpose to create the site-linked BIM model by using different software

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provided by these vendors. This is done through the following three steps:

1. Find out the corresponding BIM software for both the site and building modeling.
2. Discuss the software interoperability with other BIM tools.
3. Provide all the feasible methods of creating a site-linked building model.

BIM ARCHITECTURAL MODEL:

The architectural BIM model was created, using the Revit Architecture software. In order to illustrate how to carry out the modeling of a building using a BIM based software, a small fraction of real estate development in Cascais, near Lisbon, Portugal, was chosen as case study. The building consists of three floors; the ground floor consists of two dwellings and the remaining floors, four duplex dwellings. Each dwelling consists of bedrooms, toilets, kitchen, living room, hall and balcony. In the model, all elements represented as walls, floors, ceilings, roof, doors, windows, and handrails, were created by adapting existing 6D parametric objects in the Revit library. The components of decorative character and equipment, such as sofas, chairs, toilets, tables were used directly, merely taking into account the scale factor during their inclusion in the model. The list below presents the orderly steps in the creation of architectural BIM model:

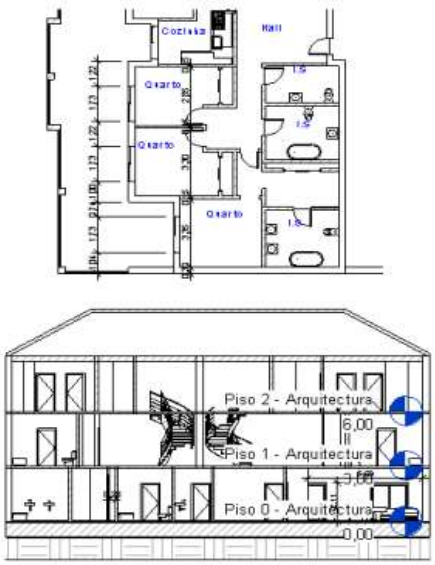

Figure:2. Ground floor plan and vertical section.

INSPECTION PROGRAM:

An inspection programme was implemented to support the maintenance work in a BIM environment. It was developed as an independent application and after linked to the BIM architectural model. The interactive inspection operations sheet, created using the Visual Basic software, has as main objective to support the elaboration of an inspection. In its development the database that was used consisted in the compilation of information from other dissertations also developed for maintenance purposes (using VR technology). The information provided in this work relates to anomalies, causes, solutions and repair methodology concerning constructive components: exterior walls, interior walls and pitched roofs. Therefore, during an inspection, the maintenance expert, when observing an anomaly, can consult the database support to fill out the inspection sheets and select the identified anomaly on the site. Subsequently, the completed inspection sheet is then converted to the and inserted into the BIM model. This model should be constantly updated, in order to accurately support the facility with repair and maintenance plans. The developed computer application has its interface illustrated in An inspection sheet must include some initial information such as identification of the technician, the date of the inspection and the identity and characteristics of the building (address, city, number of floors, year of construction, etc

BIM MODEL LINKED TO INSPECTION PROGRAM A BIM:

An application that enables access to all information created in the BIM model. Unlike the modeling software, navigation and interaction with the model is performed quickly and lighter, and can also be accessed from mobile devices such as smartphones or tablets. This type of application also allows integrating the diverse information from architectural designs, structures, building installations and budgeting, and also allows the analysis of conflict detection. This item covers how to combine the BIM model of the building, the information from the inspection form, using a BIM visualizer. In this study it was analyzed the degree of interoperability between the BIM modeler and the BIM visualizer In particular, this analyzes regards data and information transfer in the IFC format from Revit to Furthermore, an inspection form is filled in and, afterwards, saved and included in the model, so that it can be used as a

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basis for consultation when planning maintenance operations. The data transfer between the BIM modeler and visualizer, in IFC standard, resulted in complete preservation of information and error free. So, it permits to conclude that the degree of interoperability between the used software is efficient in what concerns data transfer. The only limitations observed were the clutter of information and a lack of storage capacity of the previously predefined colors, which led to the total deprivation of color of the model, as illustrated in Fig

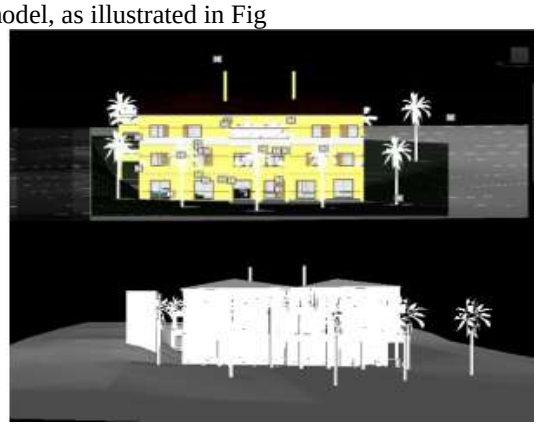

Figure:3. the colour deprivation in the IFC format

III. IMPLEMENTATION PROBLEMS:

The creation of the inspection sheet had some problems, particularly concerning the creation of a routine that allows the insertion of any picture on the form, and in obtaining However, the creation of an inspection sheet to support the maintenance of buildings, based on a BIM model would be unsuccessful if the digital modeling of a building wasn't performed. Therefore, parallel to the creation of the inspection form, an architectural BIM model was developed from scratch, being described every step of its development, illustrating the procedures of its establishment and insertion of distinct data type, with the objective of providing the building relevant information, which could be reused. Then, the modeling was exported using the IFC format to a BIM visualizer so that it could be displayed in a fast and efficient manner. The implementation of the model was done not only as a necessity, but also in order to study one of the major obstacles to the implementation of BIM, its interoperability under the IFC format. In fact, this work confirms that the IFC format is not yet fully developed in order to properly implement the information models, as, despite not losing any information, it features it in a disorganized manner, not retaining the color added to the model.

Autodesk Revit Architecture:

Autodesk Revit Architecture, as described by Autodesk, is a design software helps architects and designers capture and analyze early concepts, and then better maintain designs through documentation and construction in the real world design, Revit Architecture is mainly used to design buildings - walls, floors, ceilings, doors. However, very frequently, the architects would be asked to add site and structural information into the model, which required the software itself, provide tools to create topographic surface for site work. Revit Architecture provides the very easy-to-use tools for modeling and parametric design, not only for the building itself, but also for the site condition. process and reduce the unnecessary cost of using different software products, the first conceptual method this paper is researching on is the use Revit Architecture site tools for the sole purpose of realizing our goal to provide a site-linked 6 D building model.

Figure:4. Revit Architecture

For the site model, Autodesk Revit Architecture massing and site tools enable the user for conceptual design and put the building in a context of landscape environment. The topsurface in Revit can be created either by importing Google Earth Picture or drawing contours and points directly. It also has the functionalities of split or merge the surface, grading region, draw property lines, create building pad and other site components such as parking lot, daylights, trees, plants and so on. In addition, since most of the 3D building models are created by Revit Architecture/Structure, simply import or link the two Revit file together will get you the final site-linked 6 D model

Location and functional design:

The business-storage building is functionally divided into the store with warehouse and the office

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space. The form of the building is an elongated rectangle with a roof above the entrance and above delivery space. The external dimensions are 36.5 m by 16.5 m, the total gross area is 801.2 m2 and net surface is 715.3 m2. The business section (the store and the offices) has two floors, while the warehouse has a single storey and is double height. An outdoor space for cooling and heating devices is located on the south side of the building presents view on west and east façade of the building

Figure: 5.Western façade with the main entrance and east façade of the building

Technical characteristics:

Constructional design:

The foundation of a business section is made with a reinforced concrete foundation plate. The load-bearing structure is a brick wall in thickness of 30 cm. The foundation of a warehouse includes footings jointed by reinforced concrete beams. Load-bearing structure consists of reinforced concrete prefabricated elements, which are longitudinally connected with steel sections/profiles. Reinforced concrete slab is used for mezzanine structure. The slope of the flat roof is 3°, implemented by trapezoidal metal sheet and system of hydro and thermal insulation according to DIN 18234. Façade panels with intermediate glazing cover the façade. Façade panels are fixed on the mounting steel substructure.

Carpentry Aluminum:

Windows with external blinds (Uf = 1,3 W/Km2 , Ug = 1,0 W/Km2) are mounted on the façade. Interior doors are made of metal doorframes and door panels are from solid wood or glazed. The main entrance and exit into exhibition area has double sliding glass doors monitored by sensor. The warehouse is equipped by an industrial sectional roll-up door whereas in the northern part of the building is a high delivery door.

Internal surface treatment:

The final treatment of the ground in the warehouse includes surface hardened reinforced concrete plate. Final coverings in business section were carried out by means of large format tiles and carpeting in offices. Ceramics is laid on the floor of toilets; walls and ceilings of the business section are lined with plasterboard panels. Sensors for fire protection, lighting and ventilation equipment are built-in in the raster suspended ceilings.

Active technical systems, waterworks and sewerage:

Heating of business section is provided by the heat pump air/water and the floor heating system. Heating of the warehouse is supplied by the heat pump air/air, which serves for office cooling in the summer. The external units of heat pumps and air conditioning are installed in the outdoor space on the south side of the building. Forced ventilation of business section includes two heat recovery units, an integrated filter and an air inlet and outlet fan. The transfer of outside (fresh) air and exhaust air is conducted through channels. Toilets have an intake ventilation valves and discharge pipe ventilators. The building is connected to the existing water supply network. It has an indoor fire hydrants and distribution pipes for hot water. Domestic hot water is supplied centrally by a combination water heater

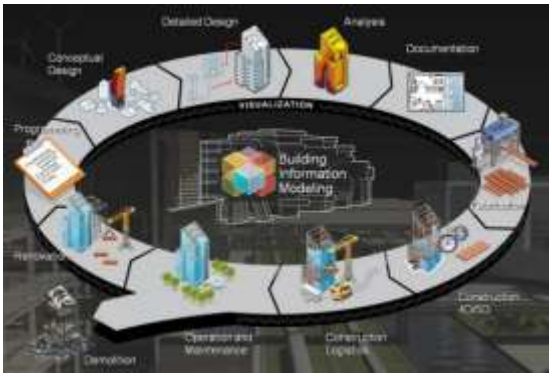

Figure:6.Use of BIM during various phases of construction

6D BIM model for business-storage building:

The following is a description of a step-by-step procedure for modeling 6D BIM in unique way. The procedure begins with the collection of information about all buildings elements and preparation of Element List for maintenance. After that, lifetime and service measures for each element are determined. Afterwards, the cost and time analysis is performed, where the cost analysis includes maintenance cost

estimation and development of 5D BIM model by applying VO (with linked data to 3D BIM model elements). The result of the time analysis is a schedule for maintenance work, displayed in MS Excel (without connection to 3D BIM model elements). The final step incorporates display/view of created 6D BIM model in tabular form.

Research method:

The overarching aim of this research is to develop the conceptual framework for seamless data transfer between BIM and FM systems. The development of this framework necessitates a general understanding of the current status of data exchange methods and requirements. Accordingly, we used semi-structured interviews method to collate more views from the industry practitioners on the current data exchange method and requirements. A total of 6 BIM experts participated in the research interviews from different organizations as shown in Table

Table: Interviewees' demographic distribution

organization type	No	Percentage (%)
Facility Management	6	37.5
Contracting	4	25.0
Architect / Engineering	2	12.5
BIM consultant	4	25.0

Element list for maintenance:

The first step to the creation of 6D BIM is to prepare an inventory of all structural and non-structural elements requiring maintenance and their quantities. In addition, inventory of all installed equipment and installation must be prepared. The present building input data are obtained from the final design and technical documentation, which contains as-built drawings, instructions for operation and maintenance, certificates of completion, Evidence on Reliability of the performed works, etc. By collecting necessary information, the so-called Element list for maintenance was prepared. To achieve the systematic approach of the 6D model, the list was prepared in tabular form. The table was divided in groups of works, namely construction and finishing works, installations, and external layout.

Determination of the lifetime and service measures for maintenance elements:

The next step towards development of 6D BIM is determining lifetime and service measures for each maintenance element. We predicted lifetime of 60 years for business-storage building. Relevant information for the individual elements is mostly taken from Rules on standards for the maintenance of apartment buildings and apartments the rule in provides maintenance standards for 323 building elements and in Annex 2 standards for 70 elements for equipment and maintenance of building lot. Maintenance standards for each element include code in relation to group of works, description of an element, normal lifetime, factor of theoretical replacement after 60 years, factor for small repairs according to a new value and mode of maintenance works

The service measures for elements from the Rule are recorded in the maintenance mode and covering a variety of activities such as: regular cleaning, regular servicing, regular review, repair of element, control of parts of the element, replacement of worn or damaged parts, painting, etc.

After that, three types of searches were done in these publications, according to the following keywords:

AR, BIM and Lean Construction

Lean and BIM

AR and BIM

Finally, Google Scholar search engine was used to verify the obtained results and gather any additional publication (journal, conference, book, guide, etc.) important for its number of cites, relevance of the author, etc.

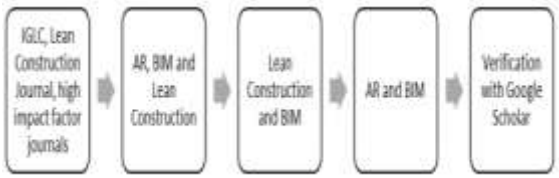

Figure: 7.Search methodology

Adoption of BIM in Modular Construction:

Modular construction or sectioned prefabrication cut down on-site manual labor expenditure and time and escalate precision in a good class construction. There are many tools and techniques voluntarily available in an illicit environment of the worksite to execute tasks more accurately, and less expensive in a shorter interlude of time Prefabrication desires effective design and field precision BIM can offer this point precision together with the stipulation, schedules, detailing and the 6 D illustration for each module On the other hand the construction team must confirm that the BIM is compatible with the software used by

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prefabrication team. Like this the constructor can use BIM and create information for the manufactured modules in their fabrication software. Once the information is approved, the modules can be fabricated using machines and robots. Besides, the construction manager must manage the procurement program of the products and make sure that prefabricated modules must be shipped to the jobsite on the dot. Complex steel structures can be welded offsite; the welding of these diminutive composite elements prior to steel erection can save time and capital.

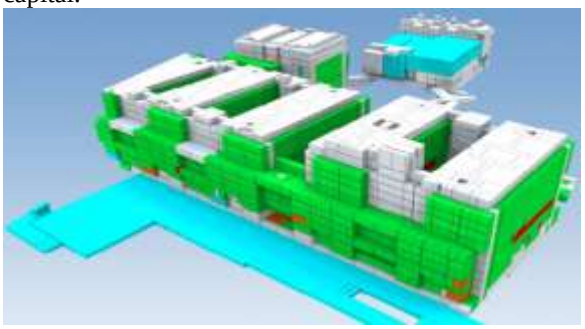

Figure:8. Modular Construction using BIM

Benefits of BIM:

Any construction project consists of a separate set of drawings for architectural, structural, mechanical, electrical, plumbing and civil. Also, there are separate set of drawings for telecommunication, landscaping, security, lighting, speaker systems and so on. Each one of these documents represents a part of the project and not everyone have access to all the documents. In most of the cases (or all), a designer from one trade (say electrical), when designing his/her system doesn't refer to other trades in the project (like mechanical, plumbing etc). Most of the times, this may result in the clashes between different trades in a project. Also, the initial drawings are mostly incomplete and the project members realize it only during the construction stage of the project. Hence before starting the work, they produce drawings which include complete information to build that part of the building. Such drawings are known as shop drawings. Thus projects are also filled with many sets of shop drawings. And then the projects have RFIs and Change Orders. Thus, a typical construction project consists of huge number of drawings/documents depending upon the size of the project. And each drawing/document consists of a piece of information about the project. When a change is made in one part of the building, all the documents affected by the change must be updated and reproduced. Sometimes the change may not be reflected accurately in other parts of the drawings. Building Information Modeling (BIM) can be a potential solution to the problems discussed so far. Building Information Modeling (BIM) is a collection of software tools which helps to coordinate the design efforts of multiple disciplines and allow for more automated and facile estimation of 33 schedule and cost.

Improved Collaboration Using IPD: In the IPD process, BIM can be used from the beginning of the design to improve the understanding of the project team members about the project requirements, co-ordination of different trades to extract cost data, which can be used to alter/improve the design at early stages without the use of paper exchange and its associated delays.

Connection between BIM and Lean design:

This chapter describes how Lean can be applied in design and how Lean processes and methods possibly can create an environment where the capabilities of BIM can be utilized. This chapter is purely relying on theory, therefore what is presented in this chapter are theoretical synergies between BIM and Lean. illustrates how the relation between BIM and Lean in the building industry can be understood. The figure depicts two overlaid circles, a big circle representing the Lean concept and a small circle representing the BIM concept. The two concepts are independent and either can or shall they replace one or another. The two circles are depicted on top of each other because the two concepts are approaching some of the same areas from different perspectives. The idea is that Lean creates an overall transparent structure for how information regarding the whole building project and BIM facilitates the part regarding model related documentation.

Figure:9. Depiction of a considered connection between BIM, Lean Design and Lean Construction

Safety/emergency management:

The critical and sensitive data is secured and accessible only for those who need it. This implies an

improvement in safety, though it must be noted that such solution leaves also room for information abuse when being given an access to. Therefore, the asset owners must ensure that BIM-data protection systems are established. During emergencies FM personnel is foremost liable of mitigating life-threatening risks and facilitating the work for emergency units.

Figure:10. Modeling the evacuation of a public building

In order to react promptly and adequately it is critical to have relevant data in place, organized in a logical and accessible way. Detailed information could be provided even before rescue units' arrival and hence professionals could develop a solution for a response and recovery more effectively. create BIM-based emergency system that provides real-time two-way information flow, creating evacuation routes based on the user's location.

Pursuing the competitive advantage:

There is no doubt that the full potential of BIM 6D has not been explored yet. Nonetheless, the authors believe that aforementioned application areas give enough reason to appreciate the importance of this emergent concept. The paper focuses on defining the most relevant technical benefits for enhancing FM practices, though it must be underlined that all conventional inefficiencies most often result in cost, time and quality deteriorations.

IV. RESULTS

Based on the measurements for the first scenario related to dissatisfaction of an occupant from the office temperature, using 6D BIM approach solves the issue in 34 minutes while the other one takes 2 hours and 23 minutes. It is clear that using 6D BIM approach saves a lot of time for facility managers and requires only one person to be completed. Results show that it is possible for facility managers to save approximately 76% in time using 6D BIM method.

6D BIM, an acronym for 6D Building Information Modeling and a term widely used in the Construction industry, refers to the intelligent linking of individual 3D CAD components or assemblies with all aspects of project life-cycle management information.

The 6D model is usually delivered to the owner when a construction project is finished. The "As-Built" BIM model is populated with relevant building component information such as product data and details, maintenance/operation manuals, cut sheet specifications, photos, warranty data, web links to product online sources, manufacturer information and contacts, etc. This database is made accessible to the users/owners through a customized proprietary web-based environment. This is intended to aid facilities managers in the operation and maintenance of the facility

Six BIM:

Utilization activities: visualization, 3D coordination, cost estimation, prefabrication, construction planning and monitoring, and record model. The visualization is generally the simplest use of a Building Information Model such as renderings. As soon as the Building Information Model are produced, the quantity takeoff s can be generated to provide cost estimations on a construction project. Furthermore, the 3D coordination was utilized to detect and eliminate trade clashes and conflicts. In addition to that, detailed prefabrication drawings can be generated to review and coordinate work between trades. Once the drawings are designed to build, the prefabrication of the components of the construction facility can be built to design. BIM based 4D scheduling helps understanding of the construction components and schedule progress that in turn results better construction planning. As the materials including but not limited to prefabricated products arrive at the job site, the planning techniques and 3D model can be combined with other BIM enabled tools to provide construction monitoring services. Based on the construction monitoring, the construction planning can be strategized. This helps to update the schedule and the 3D model. Finally, the record model can be generated as the final progress of the construction as the as-built are completely updated in the Building Information Model.

6D in a BIM environment:

The sixth dimension is still under dispute whether it exists or not. For those that believe that the sixth dimension exists it is about lifecycle cost, facilities management, and environmental impact. So actually the sixth dimension is about aspects which have an

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impact on the building and how the building has an impact on its surroundings. It is a very interesting topic that certainly deserves attention and no doubt will get attention in the next couple of years.

The Lean possibly can be a management approach to create an environment where BIM can be implemented successfully. Neither of these two management approaches can be directly applied in the design stage of a building project, but according to Schmenners Matrix every management concept consists of some of the same elements, which means that different management genres can learn from each other. As Lean design is maturing only limited material is available on the topic this section is therefore focused on explaining the core values of Lean in manufacturing and construction to show where the concept comes from. will then present some of the tools and methods from Lean manufacturing and construction which have been modified to accommodate design purposes, to document what Lean possibly can do for BIM and the other way around.

Fully utilizing BIM 6D capabilities:

Despite BIM has already been utilized during design and construction stages the previously discussed FM functionalities have not been widely applied yet. Apparently there are barriers and challenges responsible for the state of affairs, therefore remedies for them ought to be addressed

Plan and manage the implementation process:

First and foremost, BIM potential must be actively managed for its full utilization. Therefore, in order to tackle the organization-wide uncertainty/reluctance towards innovation there should be a strategic implementation plan in place suggests that leveraging the potential of BIM 6D requires a visionary owner who would lead the process from the early stages of the project delivery. Though, the authors do not fully agree since the support from the BIM manager could be a solution for the inexperienced owner too.

Collaborative approach towards Facilities:

Design It is argued that the integration of the asset owner/end-user and facility manager has pivotal implications for O&M phase, provided that is made at the early stages of the project delivery Since the FM professionals are valuable source of information concerning end-users' expectations then their input in shaping the owner's requirements is beneficial for both sides The level of detail of the BIM model can be established effectively on the grounds of this relationship. The LOD (level of development) must reflect business needs and in many cases lower detail may be sufficient for FM team

Time:

The time-aspect of BIM is considered the fourth dimension: "6D models include information that can inform and analyze project phasing, tenant sequencing, and construction scheduling As an obvious improvement, scheduling was one of the first aspects of BIM, added to geometrical models. A 6 D model can be used to simulate the project at any given time, as is shown in Figure 8. This enables the user to simulate construction, recognize clashes, and organize the building site at every construction phase Another important aspect is the marketability and communicability of the 6 D model, because it can be used as communication tool to stakeholders used a 6 D BIM model, in collaboration with scheduling software, to set and monitor milestones, to produce a preview of the next four weeks, and to extract weekly plans from quality assignments

Figure:11. Example of a view on a building site at a given time

Figure:12. 6D modeling structure

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Figure:13.Isometric view 6D Model

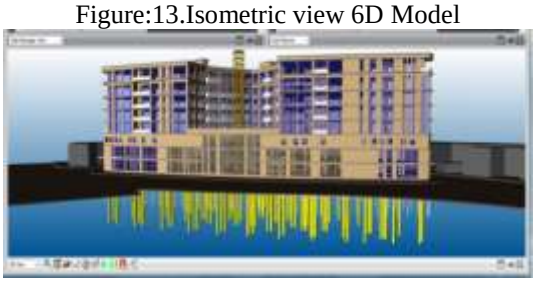

Figure:14. Example of visual cost planning in 6 D model

V. CONCLUSIONS:

BIM creates competency and also help users to get several benefits. It reflects the fact that users of all levels could see BIM as helping them work better, but cost savings are more likely to be realized by experienced users. This is achieved by presenting the application areas of BIM-enabled processes, bearing in mind the seamless information flow as a pre-requisite. Furthermore, existing challenges and barriers that hinder the successful employment and application of BIM 6D are identified and a solution in the form of an action plan is provided. Understanding conventional FM practices allows establishing a performance gap, primarily attributed to inefficiencies in the information management across the building asset lifecycle and lack of collaborative attitude among actors within the industry. Furthermore, BIM as a collaborative process that facilitates the sustained logistics of information is introduced as viable way of bridging the gap identified earlier. Developing awareness of FM application areas for BIM-enabled processes is the first step towards appreciating BIM 6D potential By presenting explicit evidence of BIM applicability for FM practices the paper introduces researchers and foremost practitioners to the clear concept potential. Future work should focus on experimenting through larger number of case studies to ensure and verify the construction industry of the practical applicability and feasibility of implementing BIM 6Dimplementing BIM-based revolution, it is the construction industry's inability to cooperate. However, the industry is continually evolving being led by BIM development hence the authors believe that all the aforementioned issues could be gradually diminished and eventually solved.

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