

Using Virtual Reality and Augmented Reality for Presale House Customer Change

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Abstract –

Using Building Information Modeling (BIM) technology, a unique virtual model of a project can be created, which will allow all parties involved in the design process of project members (owners, architects, engineers, contractors, sub-contractors and suppliers) to collaborate more precisely and more effectively than using traditional processes. The collaboration of the different parties must be linked by a functional system with the presence of software, the team members constantly refine and adjust their portions according to the project specifications and design modifications to guarantee that the model is as precise. Augmented Reality (AR) in turn can bridge the cognitive gap between pre-sale products and real products. Although the presence of Augmented Reality (AR) and Virtual Reality (VR) is necessary, it is necessary to establish a system that directly connects AR, VR, the company, clients, investors and various construction documents. This VR system will be used in the functions of the pre-sale houses between companies, owners and investors. The project that will be used for this study is a building of five floors and two basement located in the District of Zhonghe in Taiwan. As the result showed, for the presentation of the presale house, the technique of the Event-Driven Process Chain (EPC) diagram is used including the import and export of several files. In addition the diagram system gives customers the opportunity to make changes regarding materials, design and time liner in future construction. These different changes made by the customers and approved by the company will generate consequences for the initial contract drawn up by the company. The software Fuzor to ensure the realization of the VR and AR while maintaining a concordance of the different stages of the diagram. To satisfy the requests of the ownership of, the project price and timing, Navisworks and Revit have also allowed the good management of the project. The EPC diagram will have two alternatives, the first alternative will be proposed by the company

according to the demand on the market. Then follow the second alternative, this will be the new proposals suggested by the customers after consulting the proposals of the company using VR and AR. At the end of these various changes by the EPC system the prices of materials, other design, the implication of equipment, labor, materials and subcontractors will be updated according to the proposal of the owner.

Keywords –

Augmented Reality (AR); Virtual Reality (VR); Presale House; Building Information Modeling (BIM); Event-driven Process Chain (EPC) concept.

1. Introduction

In the 1960s, rapid economic development in several Asian countries, including Taiwan, Hong Kong, China, Singapore, South Korea, Indonesia and Malaysia, led to an explosion in demand for housing in several major cities. This growth in housing demand also reflected the economic status of these countries [1]. The solution to this growing demand, a unique and innovative presale housing system was developed, and has been adopted and developed since then. These house pre-sales refer to the contractual sales of housing before the construction of the construction project, i.e. the management companies design a building and start to build or before construction try to make offers to customers for the purchase of their houses. With this system, companies can receive pre-contracts which will allow them to finance future construction. Some customers in order to guarantee a good future for their families will be interested, the pre-sale accommodation can be purchased at a reduced price and they acquire property rights in advance. In addition, home buyers can participate in and oversee the advancement through the VR and AR of the housing project to secure their property rights at the end of the project, and even make proposals during construction [1]. Use to gain customer trust. This requires creating beautiful reception centers and hiring professional real estate sales agents. This

strategy requires a lot of expense, which is a major drawback for companies. Through architectural models, a plan for implementing 3D product perspectives and models coupled with examples of housing, the companies are trying to improve the understanding of investors and customers to stimulate purchase intention. Many customers are dissatisfied after the construction of their infrastructure works, most of these problems are due to the fact that the owner does not really know what his project will look like after construction and the delay in construction. To solve this problem new technique have been developed in this study [2].

2. Presale house presentation

2.1 Research content

The concept of the Event-driven Process Chain (EPC) diagram will be used for the presentation of the presale house.

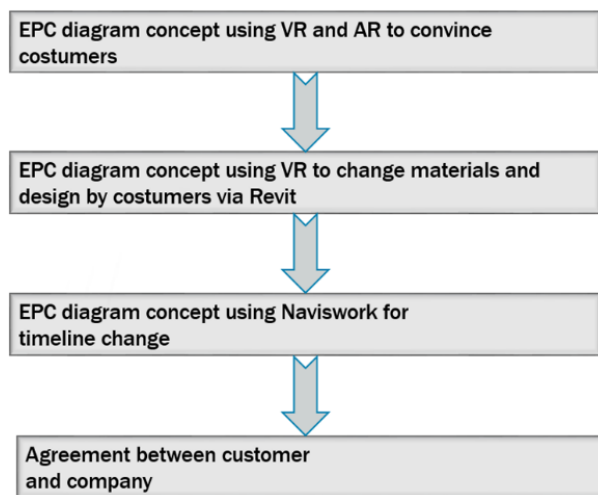


Figure 2.1. Work process

This diagram highlights an intersecting connection between the different parts of the construction. The objective is to convince the owner or investors to buy or place an order before finalizing the construction.

2.2 Diagram of the presale house presentation

In this study for a good presentation and convincing of the presale house, the concept EPC was used. The EPC is a flowchart for business process modeling for product management through multiple partners. EPC can be used to configure company resource planning execution with the aim of structuring all the details in time and in their place, and for business process improvement. Used to control an autonomous workflow instance in work sharing represent in Figure 2.2.

In this study Events are passive elements in event-driven process chains. That event describes under what circumstances a function or a process works or which state a function (Navisworks, Revit, Fuzor) or a process results in. Then the function described below.

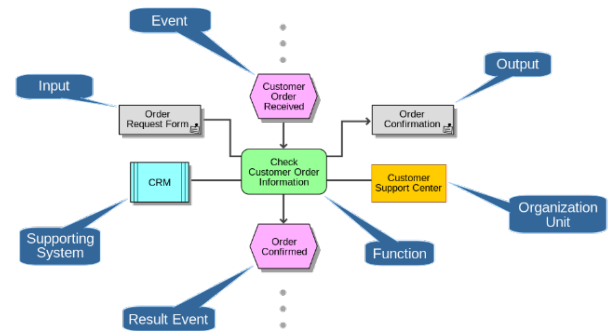


Figure 2.2. Event-driven Process Chain

The function of the figures used:

- Event and result event
- Information: output and input documents
- Function
- Supporting system
- Organizational unit type

Figure 2.3 explains the strategies implemented to present the 3D model by the company to the owners. This strategy involves the creation of a 3D animation of the project from the Revit file.

The experimentation is based on a construction project in the district of zhonghe. The project comprises a building of five (5) floors and two bases for habitation. The building will be built in a residential area. The two bases will be used for parking. This experiment will focus on the project information.

In this study the responsibility is to convince the customers or investors to buy or rent the room (building) during or before the construction phase. To convince customers or investors several ideas has been established in which softwires and new technologies will be use.

Owner of the entire building: The whole building belongs to a single structure and all decisions will be specific to these people.

Inspection by Virtual Reality: Step1 owners order to company using Fuzor

In this first step the company uses Fuzor software for a complete presentation of the building to the owners. This presentation concerns the exterior and interior designs. This function will obviously need supporting systems and information (input documents function). This is how the second and the third step, which are respectively construction type to the company, Step2 and Virtual view to the company Step3, will take

place.

In Step 3 the first presentation will be done by VR BOX headset. This involves the use of the Fuzor application on smart phone. First use the Fuzor software to output the construction file in FZM format, then transfer it to the smart phone, then open the file using the Fuzor application. The owner can start to see the virtual view of his future home. The Fuzor 3D view, the company will use the synchronization system from the Revit software to open the project.

This synchronization system is very important because it will facilitate the work when the owner will

make a decision regarding a change. After the synchronization the file of the project will be opened on Fuzor.

For the good vision of the project, the environment in which the project will be implemented will be presented to the owner with the presence of his future building. This presentation will be done by Mixed Reality (MR) [4]. The 3D photo model (presented in Figure 2.4 and 2.5) of the construction environment produced by the Bentley contextcapture software which was the subject of the first part of this study.

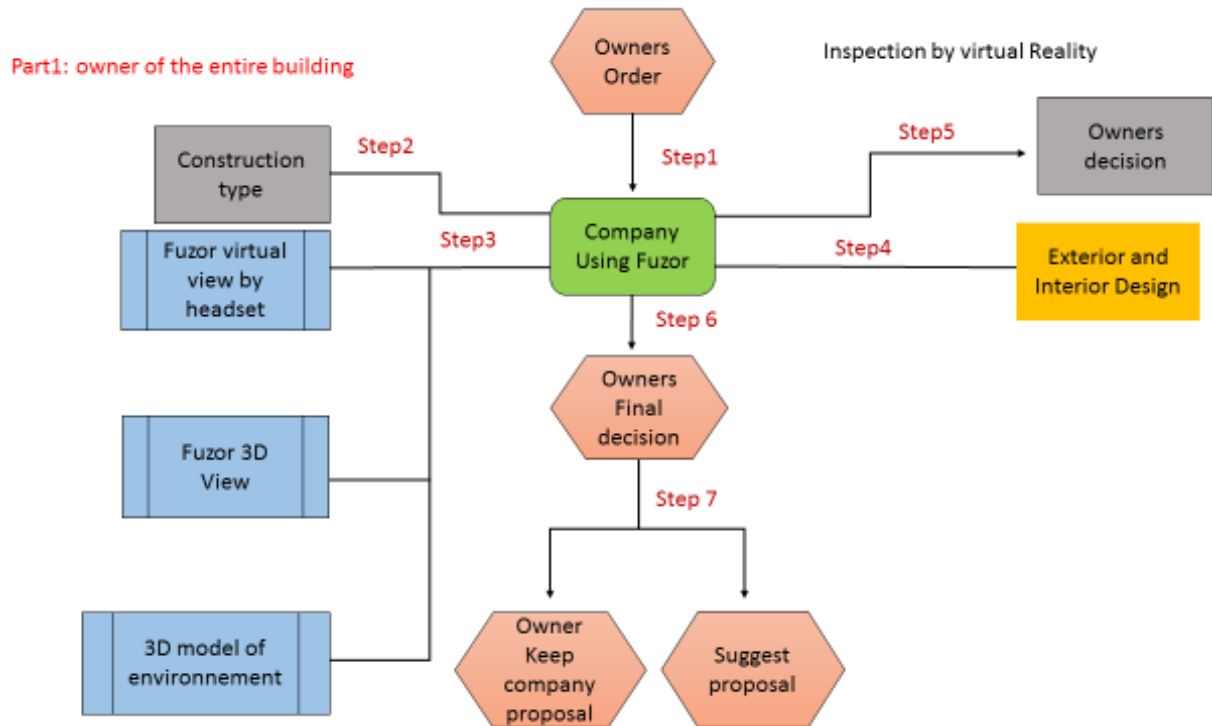


Figure 2.3. Inspection by Virtual Reality



Figure 2.4.3D photo model Augmented Reality1

For this fact the 3Dmax software will be used, initially the two files will be input in the software 3Dmax namely the format FBX coming from Bentley context capture and the format FBX of the construction



Figure 2.5.3D photo model Augmented Reality2

coming from Fuzor. In the 3DMax software the 3D model of the construction will be positioned exactly in the space dedicated to the implementation of the project, this is illustrated in Figure 2.6 [5].

MR shows in Figure 2.6 technology allow real and virtual elements to interact with one another and the user to interact with virtual elements like owners viewing their construction in real world. How does MR work? There must be an MR device, either a headset or translucent glasses, in this VR BOX study was used to create the experience [6].

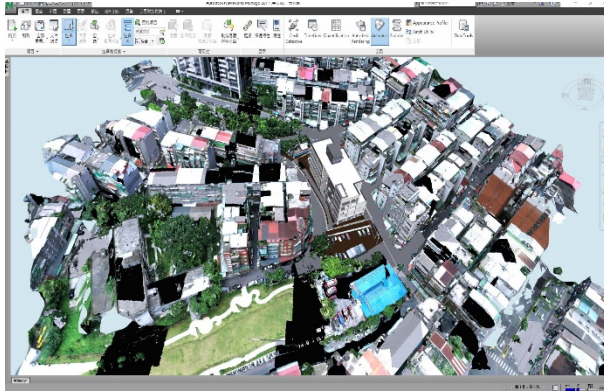


Figure 2.6. Mixed Reality

Using much more processing power than VR, Augmented Reality (AR) and AR technology connects the virtual and real worlds in a single connected experience like combining two visions into one using visual / gesture recognition technology / voice via headset or a pair of motion controllers. In this project, the mixed product was used to introduce the owner to the environment of his new construction. To allow him to understand the situation in which his future building will be presented. Since AR maintains a connection with the real world, it is not considered as a completely immersive experience [7]. In a MR environment, wherever user go and watch when he wear MR technology, the 3D content allow him to meet in space will react in the same way as in the real world under these conditions the owners are assured of see their construction in a real and precise event. In this example study, an object will approach the owner when it changes movement, the object will approach and interact with it [8].

Step 4 will be the subject of the design, i.e. the exterior and interior design. This will be about what types of materials to use.

Step 5 represents an output of the files used in the different software from the information received beforehand for the development of the project.

After submitting the details of the project to the owners, Step 6 will be the owner's decision. The decision of the owner will either keep the proposal of the company or give his own suggestions to change the design, Step 7 shows. If the owner decides to make changes this leads to called Change in Materials and

Prices.

3. Change in materials and prices

3.1 The cost of the materials of the structure:

Construction materials are priced by weight or number that of structural steel is normally priced by weight, so it is important to have a clear idea of the structural sections that will be used and the meaning of the lettering of each section to establish an accurate estimate [9].

These structural sections are already chosen according to the construction model established beforehand by the company as shown in Figure 3.1.

Type	Diameter / mm	Pipe cost / \$/m	Installation cost / \$/m	Total cost / \$/m
PVC-1075	75	6,47	12,53	19
PVC-10110	110	11,91	13,5	25,41
PVC-10140	140	18,32	14,34	32,66
PVC-10200	200	30,66	16,11	46,77
PVC-10315	315	60,2	19,74	79,94
PVC-10400	400	95,3	22,64	117,94
HDPE-1075	75	8,85	12,53	21,38
HDPE-10110	110	15,1	13,5	28,6
HDPE-10140	140	20,9	14,34	35,24
HDPE-10200	200	36,69	16,11	52,8
HDPE-10315	315	75,52	19,74	95,26
HDPE-10400	400	119,4	22,64	142,04
HDPE-101000	1000	771,13	57,73	828,86
STEEL75	76	46,74	12,56	59,3
STEEL110	110	53,11	13,27	66,38
STEEL160	160	77,12	14,69	91,81
STEEL200	200	96,51	16,2	112,71
STEEL315	315	139,36	19,84	159,2
STEEL400	400	177,18	23,37	200,55
STEEL1000	1000	405,47	58,71	464,18

Figure 3.1.MEP materials cost

3.2 The cost of the materials of the mechanical, electrical, and plumbing (MEP):

The construction obviously needs a mechanical part in its structuring, the mechanical parts are generally subcontracted to mechanical specialties, which prepare detailed quotes for the plumbing and heating, ventilation and air conditioning (HVAC) systems, this part plumbing promotes comfort in the management of the structure. To accurately estimate plumbing costs, construction contributor must therefore have field experience and a good knowledge of various plumbing systems, materials, labor and equipment, as well as " an understanding of the design and internal and external specifications of the structure. This simply transfers the

preparation of the detailed estimate to another party, but this does not eliminate the need to estimate and analyze the prices indicated by the engineers [11].

Part1: owner of the entire building

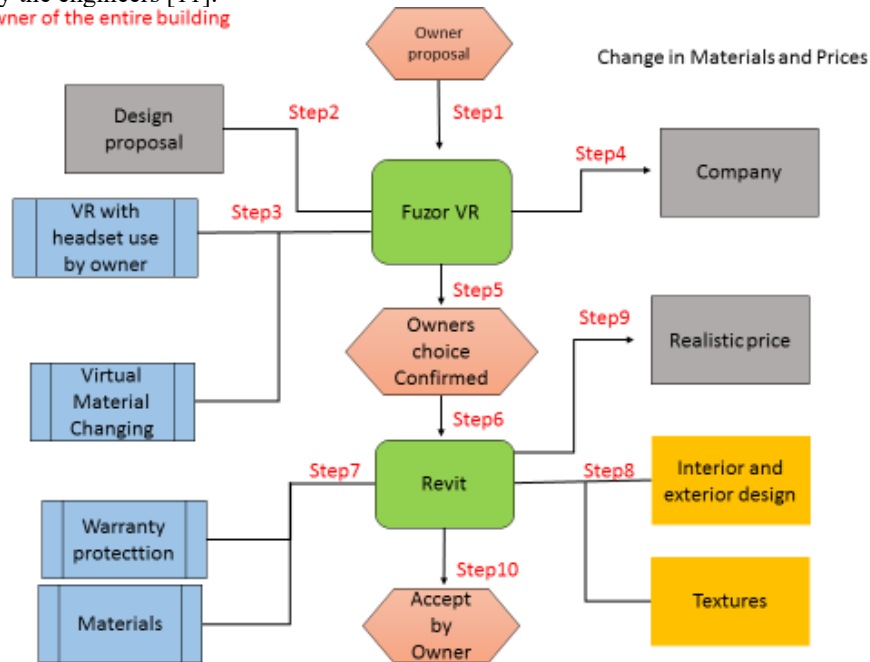


Figure 3.2. Change in Materials and prices

Step 1 explains the changes proposed by the owner. These different changes suggested by the owner will be recorded in project document at Step 2. Fuzor software by VR function will help the owner to make these changes while taking into account the material already submitted by the company.

Step 3 demonstrates the change in the model by the owner. This is done from the VR Box headset or directly on the Fuzor software, and from the already done synchronization above the materials that are changed or created directly translates to the main model of Revit, Figure 3.3 shows a synchronization view between Fuzor and Revit.

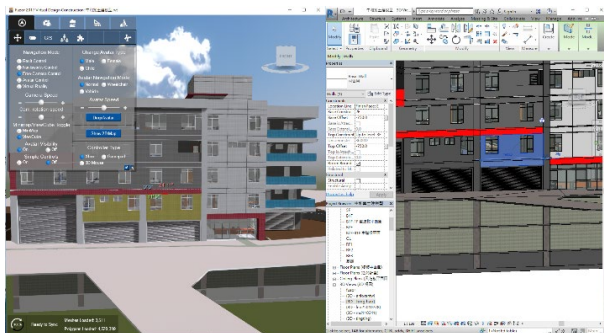


Figure 3.3. Synchronization between Fuzor and Revit

In this project the owner has had to change the

Figure 3.2, relates the finalization of the owner decision regarding the change of materials.

design exterior first by modifying by itself the shape of the wall. For the modification, the owner prefers to insert a balcony at each floor, illustrate in Figure 3.4.

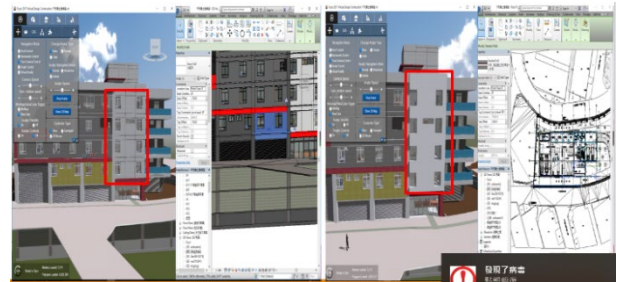


Figure 3.4. Design change

3.3 Interactive clash management:

The functioning of the interactive clash defines interference and proximity tolerances. To start it, it is necessary to select sections of the building, systems or types of objects to compare, then define the tolerance and execute the conflict check [13]. This procedure will allow Fuzor to list all the conflicts according to defined criteria and lists them in the conflict interface. By clicking on any conflict in the list, accessing this conflict results in highlighting the objects in conflict. After the different changes the clash management system (tolerances 0.83) of Fuzor was used to detect the

presence of indifference in the design. Figure 4.16. Shows that there is no clash problem after changing the facade of the wall by including several balconies, the same result is observed at the change of the exterior texture from yellow to blue. But after changing the size of the wall inside the level 2 chamber, a clash was detected. This was the subject of a bug fix on the Revit software. This error is mentioned in Figure 3.6 in red object [13].

Step 4 will contain data collection after the various modifications. This document contains the price, the size, and the colors of the different materials. This document will be used by the company later to fix the prices and the timeline of execution of the works.

At Step 5, the different changes are finished, and the owner is satisfied with the design of its construction. The company has confirmation from the owner about the texture, the choice of materials and the modeling of the construction.

In Step 6 the changes will be transferred to the Revit software for price validation, material verification and their warranty. This transfer between the two programs is already established by the plugin system in the previous steps.

Step 7 All materials used in the project are chosen according to their quality. These qualities are closely linked to their guarantee, the objective is to present an excellent project in the choice of materials and economically favorable.

In step 8 usually the owners are more focused on the appearance of their home, regarding the exterior and interior design, the texture. These different elements are crucial in the context to convince them. It is to this extent that very special importance was devoted to this part. The interior design can easily be modified if the need arises. The size of furniture, doors, windows etc... can be altered. Partitions can be moved and rearranged. Making these changes in Revit is very simple and does not require much time either. It is possible to replicate and resize furniture without much effort.

For the realistic price in Step 9, the construction cost estimate is the process of forecasting the cost of construction of a physical structure that is established according to needs and modalities.

4. TimeLine management for presale house presentation

4.1 The setting of the timeline by the company

This diagram (Figure 4.1) presents a flexibility of work between the owner, the company and the different working associates. This is a method which gives the choice to all the participants of the project to freely express for a more balanced management of working

time. This diagram is presented in several steps that will often require the desires of the owner.

Step 1: In the first step the company will be the source of manipulation of documents, software and agreements collected at stakeholder level for an adequate balance of the progress of the project.

Step 2, in this part the NWD format to collect at Revit level will import into Navisworks as the diagram specifies.

Step 3, the 3D model of the building space already produced will be used to show the evolution and timing of the building to the owner. This part is a mix of the model produced by Revit and the 3D model produced by Bentley contextcapture. This technique aims to present the owner in what environment will present his new construction. This will also prove the credibility of the planning that will be made later and show the conditions of the realization of the project. Then in the setting of the timeliner organization unit of Step 4 will be a major factor, which are the structure of the building and the MEP. In Step 5, project planning is a crucial element in the relationship between the owner and the company. In Step 6 it will be necessary to transfer to the owner online each step of execution of the project. This will enable him to follow in progress the different phases of the workings. This also aims at pushing the company to respect the deadlines.

In Step 7 after having shown the owner the time of execution of the work he can accept or propose another schedule that suits him. If the owner accepts the schedule of the company the work will take place as such. If the owner suggests another period for the planning this leads to the Timeline B Figure 4.1, which is timelines B.

Timeline B, explains in detail if the owner decides to give a new schedule of the final delivery of the project.

Step1, in this part the owner has decided to change the time of the construction for personal reasons. Consequently, the owner must provide its period of the end of the works. This calendar will be first examined by the company for its feasibility.

In the second Step, the company received the owner's claims, this information was input into the Navisworks software and later produced data.

In order to carry out Step 3 which changes the planning, Step 4 concerning the organization unit (labor, material, equipment, and subcontractor) will be crucial elements. First of all, the different elements that must be influenced by the change of the schedule must be defined.

4.2 A specific part of the building belonging to the owner

Alternative 2: A room or floor level owned by the owner

The inspection of the reality virtual is the same thing as that of the owner for all the building. The

parameterize and the use of the files remains the same, in Figure 4.2.

Part1: owner of the entire building

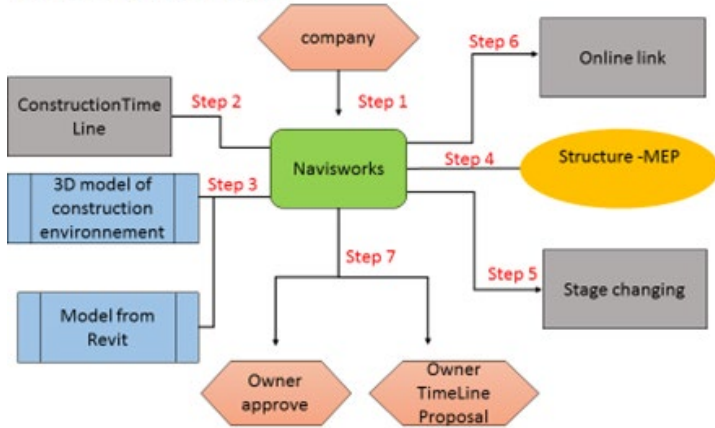


Figure 4.1. Timeline B

The price and setting of the materials remains the same, except that the setting will not take into account the exterior design, in Figure 4.3. The timeliner of

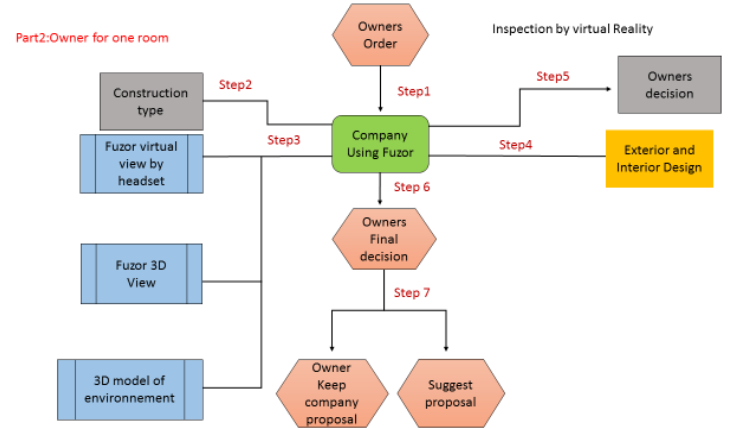


Figure 4.2. Inspection by Virtual Reality

Navisworks will be the same, except that the owner will have no suggestion to make compared to the time of execution.

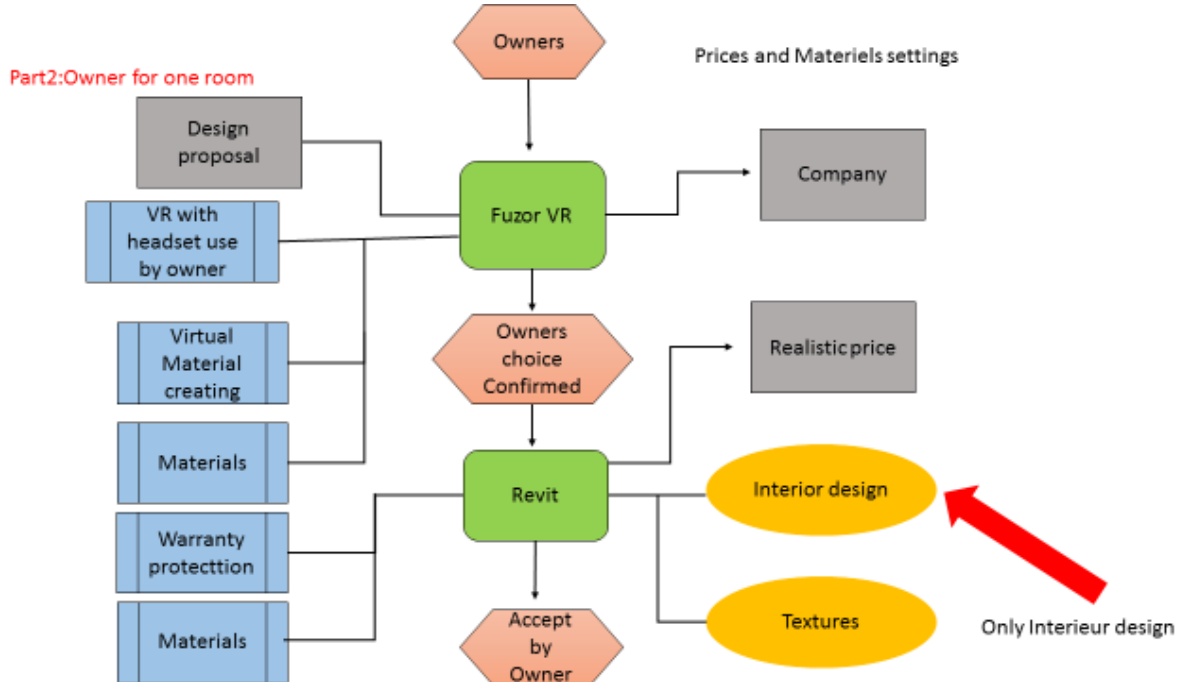


Figure 4.3. Prices and Materials settings

5. Discussion

After having given the owners of the project the choice of design, time and materials, the observation was made in relation to the price because the customer will always want what is comfortable and durable but do not want to invest the necessary money. So to

facilitate partnership it was necessary to try to involve the catalogs of the materials. This catalog will be considered as a trust course between the different partners. It should also be emphasized that the use of VR for the presentation of the presale house is a very positive idea for future of owners. They note the perception of their future home and suggestions if possible. Regardless of budget, just about every

developer, realtor, architect, or interior designer can take advantage of VR and AR to showcase a project inside.

VR can show off a project at any stage, from pre-construction to proposed renovations and upgrades. VR with the synchronization system can be customized and quickly updated, complete with interactive components that allow prospective homeowners or builders to change finishes, fabrics, layout ideas, and more. Whether it is the structural part or the MEP, everything is detailed in the report to submit to the owner.

In the analysis of this study of EPC diagram, the observation is that whenever the time of construction has been changed by the owner the load of labor has increased considerably. This means that the company needs to be more lenient in partnering with the subcontractors for efficient execution and on time.

5.1 Conclusion

Traditional way presents many disagreements between costumers and company Owners can make change at the project to solve disagree and delay problems. This study has also allowed to identify some concerns of the owners in the future, about comfort and safety.

In this study the contribution was considerable compared to the previous researches on which the study is focused. The advantage is the technique and the software used allowed efficiency in the study, less time was used compared to the other researches. The major advantage is gaining trust among owners and investors.

5.2 Future work

Future research will be based on the difficulties encountered in the execution of these projects. In addition the new ideas will come from the suggestions given by the different partners for the good execution.

Create a function that allows the owner of a single room or a single level of construction to suggest the construction time.

Using the system of a mobile phone application, project participants can easily view, add a profile to the system and set permissions for what new employees are allowed to do, while following the roadmap of the project. Additionally, tools can be labeled with QR codes to ensure they are easy to find.

Developing a function to adjust parameters such as the number of workers, available equipment and construction materials can be done to show how these changes would affect the cost of the project with a connection of Navisworks and Revit to control the data and the time required for completion.

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