COLLABORATIVE FINANCIAL FEASIBILITY WITH CAAD FOR RESIDENTIAL DEVELOPMENT

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Abstract. Computer Aided Architectural Design software is a necessary tool for the architectural design of a visible object or model. In residential development, an estimation of time/cost corresponding to the design is needed in order to complete its successful project. But available feasibility supporting tools usually lacks ability to share their information. To solve this limitation, this research proposes a design of Graphic User Interface (GUI) for collaborative financial feasibility through an architectural design process in housing project. The development of the GUI starts from collecting some information and requirement from National Housing Authority of Thailand. A heuristic decision making approach based on financial analysis are then designed for both design processes and feasibility processes of the project. Finally, design of the GUI is an integration of CAAD engines, design standards and financial feasibility analysis. Proposed GUI for collaborative financial feasibility is also tested and verified with some information from sample past projects of the National Housing Authority. From the experimental results, This GUI allows designers to improve the design of the project in real-time by inspecting the result of their design via the part of the architectural design-oriented GUI called myMonitoring and Scratch Pad. Together with planning, collaborative financial feasibility is focusing on the four main financial parameters which illustrated the possible chance of the project: Net Present Value (NPV), Benefit-Cost Ratio (B/C), Internal Rate of Return (IRR), and Payback Period. The core system was developed on Java Technology such as JSP and Swing empowered by 3D game engine. In addition, "Virtools" as an authoring tool was applied to improve interactive 3D virtual environment and explore rapid online system prototyping.

Keywords. Collaborative: Financial Feasibility; CAAD; Residential Development; Virtual Reality (VR).

1. Background

Computer Aided Architectural Design (CAAD) software is a necessary tool for the architectural design of a visible object or model. In residential development, an estimation of time/cost corresponding to the design is needed in order to complete its successful project. At the Planning and design phase focusing on design and financial feasibility, this has traditionally been based on physical meetings with insufficient information or information overflow between representatives of the principal design disciplines and financial evaluation information. Moreover, design and feasibility process of a housing project usually require high complexity of time and resources. To aid these integrate practice, the information and communications technologies that are currently available have been utilized. But available feasibility supporting tools usually lacks ability to share their information. These have yielded some success but are hampered by the problems posed by the use of heterogeneous software tools and the lack of effective collaboration tools that are necessary to collapse the time and misunderstanding constraints, within which increasingly global design team's work. To solve this limitation, this research proposes a design of Graphic User Interface (GUI) for collaborative financial feasibility through an architectural design process in housing project. The development of the GUI starts from collecting some information and requirement from National Housing Authority of Thailand (NHA) (Figure 1). A heuristic decision making approach based on financial analysis are then designed for both design processes and feasibility processes of the project. Finally, design of the GUI is an integration of CAAD engines, design standards and financial feasibility analysis.

The core system was developed on Java Technology such as JSP and Swing empowered by 3D game engine. In addition, "Virtools" as an authoring tool was applied to improve interactive 3D virtual environment and explore rapid online system prototyping.

Figure 1. NHA Project Development (Faculty of Architecture and Planning, 2008).

2. Present Digital Perception

Architecture, one of the oldest crossroads of arts and science, has been using information processing devices for centuries. These devices were sometimes in the form of measuring and drafting tools, sometimes in the form of wooden and paper models and, most recently, in the form of computers (Abdullah, Md. Emran and Md. Shabab, 2005). The technology that gives the architects the freedom of thinking enormously and broadens communication between themselves and the client community is not very old practice. The problem solving that usually happen in the early design phase is the tool that can speed up and accurate the project. As de Vries and Wagter (1990) said Computer-aided design technology has been adopted widely as a useful tool for speeding up and improving the design process. Today CAD systems are being used more often as a drafting package, but fail in action of design and decision support system because they are not actually concern in the requirement of the parties in the project.

Workstations (computer) are very recent equipment in architectural firms. Architecture has become a database containing information about the inhabitants, providing space quality according to the choice of the occupant. Michael Benedikt sees the distinctive achievement of the computer age as the marriage of digital design and physical presentation (Aaron, 1997).

But this emancipation is in the form of only a new fixture in architectural firms. Without the perception of the futurism or the global Economy, Computer technology is just a drafting tool that can perform faster than the past.

2.1. CAD HISTORY: SEVEN GENERATIONS OF CAD

Mitchell (1990) summarizes the process of five generations of CAD since early 60's, to which Caffarena (2002) have added two more in the 2000's. Although the 50's had seen the birth of CAD at the experimental level, the first generation only started in the 60's. Ivan Sutherland's SKETCHPAD, presented as a doctoral thesis at MIT in 1963, is often cited as the very first interactive CAD system, which combined data-manipulation with graphic displays. In the 70's, with more affordable 16-bit minicomputers, a second generation of commercially available CAD systems began. Those were expensive, turnkey systems, providing the hardware, software, installation, training, and technical support. These second generation CAD systems were use in public construction with repetition in Britain, and by large engineering and architectural firms in the U.S., still operated mainly by technician. The 80's saw the parallel development of three different generation of CAD, and an intention to realize its potential through new methodologies and practices (Kalay, 1987), such as architectural expert systems. Those were "rule-based and/or frame-based systems that provide the means for codifying the problem-solving know-how of human-experts" (Schmitt, 1987 p.213). The third generation was a natural continuation of the previous two: with the new 32-bit super-minis, more large engineering and architectural firms acquired turnkey CAD systems. They were also introduced to some architecture schools, but still as a secondary activity. At the same time, a fourth generation of simplified CAD was being developed to be used in the new 16-bit IBM and Apple Macintosh personal computers, finally making CAD affordable to small firms and independent architects. The fifth generation of CAD was related to the development of a new kind of computer in the 80's: the graphic workstation. Their 3D-modeling capabilities led to a discussion about the role of solids modeling in the design process and in the replacement of traditional bi-dimensional design representation (Eastman, 1987).

By the end of the decade, there was no substantial difference between PC's and workstations both in price and in performance, giving rise to what can be perceived as a sixth generation of CAD. During the 90's, CAD become not only a pattern, but also a necessity in every architectural office, in the same way as word processors completely substituted typewriters. CAD became a synonym of productivity. The introduction of 3D Modeling, a rendering and communication capability to the originally simplified PC CAD systems was made possible by the increasing power of microprocessor.

Finally, still during the 90's, a seventh generation of do-it-yourself or home design CAD packages, destined to dwellers, rather than architects, has allowed users to design American style houses based on standardized building materials. Although limited, they offer much more freedom than the early pre-fabrication CAD systems from 70's. Those system not only perform the structural analysis of the wood frame and produce complete building documents based on standard details, ready for printing, but also make the "Designers" very proud of themselves.

2.2. THE EIGHT GENERATIONS OF CAD

As the forecast of the eight and last generation of CAD by Caffarena (2002), in what concerns future developments, a clear direction is being taken towards web-based and wireless CAD that allow remote collaboration and on-the-go work, which is a characteristic of the eight and last generation. Learning capabilities, which are already present in programs such as text editors, will also be incorporated to drawing editors. Another probable line of development relates to interactive interfaces. So the design of GUI for collaborative methods is required.

2.3. CAD LIMITATION IN THAILAND

The situation in Thailand is also the same as Abdullah, Md. Emran and Md. Shabab (2005) said at present, it is hard to find an architectural firm without any workstation. In all phases of planning and designing, computers are used in documenting, organizing and storing information; to visualise design alternatives and to produce working drawings or 3D models for construction workers. Due to this fact, architectural firms require various types of drafting software like AutoCAD, MiniCAD, ArchiCAD; graphics software, like Adobe Illustrator, Corel Draw; image manipulation software like Adobe Photoshop, Corel Photopaint, Morph; video editing software like Adobe Premiere and 3D modelling and animation softwares like 3D Studio Max, Maya, Form Z, and Microstation. These softwares are being developed and appreciated both by users and clients. Moreover, analytical and simulation software like Spiel, Space syntax, Ansys, Shadow Pac, EZ Flow, Town scope, Daylight, etc. are also becoming popular among both professionals and academics.

According to Peter Zellner (1999), "Architecture need no longer be generated through the static conventions of plan, section and elevation. Instead, buildings can now be fully formed in three-dimensional modelling, profiling, prototyping and manufacturing software, interfaces and hardware, thus collapsing the stages between conceptualization and fabrication, production and construction".

This is illustrated the fragment of software using in construction industry. The next solution is the complicated grouping or creating the international file format. Nowadays, many huge software companies try to create the solution package for the whole process in the construction industry but yet it does not seem to be the widespread use in Thailand. CAD generation in Thailand is still in the early Seven generation and it seems to be freeze in this generation and never move forward to the next step.

3. Managing the Huge Essential Information

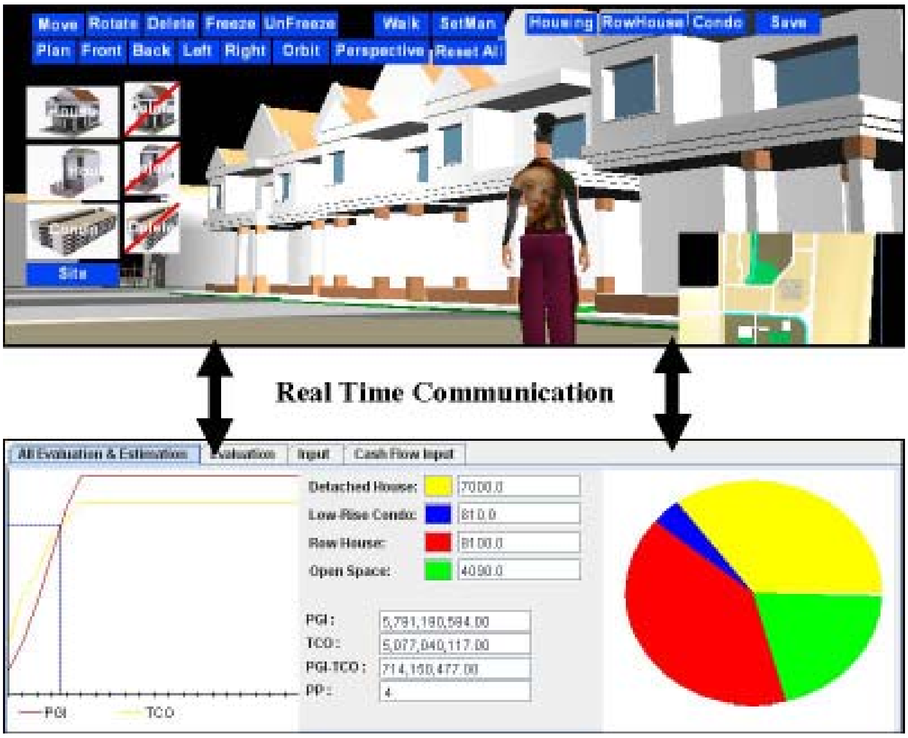

Figure 2. VR Communication with Financial Feasibility GUI.

This paper describes a unique coupling of Interactive 3D Virtual Environment with collaborative financial feasibility in order to manage a large number of essential information more efficiently. Housing Feasibility implies extensive knowledge of financial analysis and concepts of urban planning with detailed architectural construction. Architects and planners can use the functionality of the collaborative system on design simulation, 3D virtual environment, cost estimation, land-use allocation, feasibility analysis and online CAAD aspects. Providing sufficiently appropriated housing information is also helping various users reaching their objectives respectively. So the system must offer proper information of feasibility analysis focused on design, planning, financial analysis, and related factors (Figure 2).

4. Graphic User Interface and Implementation

The four parts of user interface illustration: (1) workspace, (2) Scratch Pad, (3) myMonitoring, and (4) Feasibility Evaluation. The GUI is created by the process of Thailand pre-project feasibility. There are 3 steps to get the outcome of the software which intend to help the architect or the developer making their decision to accept or drop this project (Figure 4).

Proposed GUI for collaborative financial feasibility is also tested and verified with some information from sample past projects of the National Housing Authority. From the experimental results, This GUI allows designers to improve the design of the project in real-time by inspecting the result of their design via the part of the architectural design-oriented GUI called myMonitoring and Scratch Pad. The myMonitoring consists of three parts corresponding to laws, design standards and specific parameters of the project. The Scratch Pad speeds up the dividing building type number process. Moreover, the GUI also supports three dimensional interfaces as a virtual reality (VR) system for the collaborative project design.

Together with planning, collaborative financial feasibility is focusing on the four main financial parameters which illustrated the possible chance of the project: Net Present Value (NPV), Benefit-Cost Ratio (B/C), Internal Rate of Return (IRR), and Payback Period. Estimating performance is the decision making activity that the computer offer the most. The computer can be used to predict performance with respect to a large variety of performance aspects, which are usually prohibitively expensive due to the magnitude of required computations. One of the main features of software is the relationship modelling of essential factors such as number of residential area, utility area, green area, and building types (Figure 3).

Figure 3. Feasibility Evaluation.

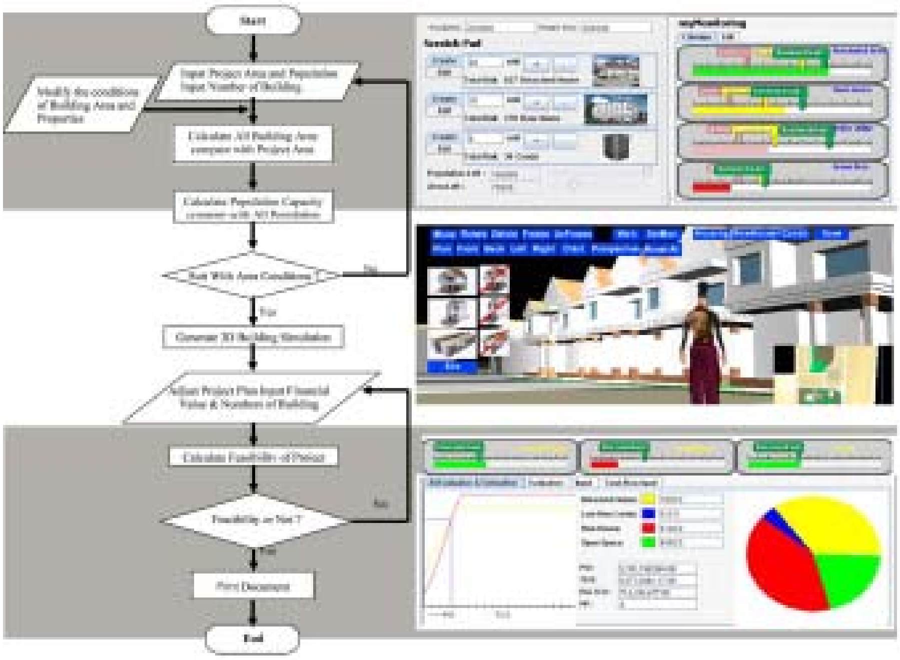

Figure 4. The 3 Steps of Proposed GUI.

The suggestion interface is to divide Thai traditional work flow into the 3 steps of proposed GUI (Figure 4). The first step is to trial and error the amount of the building that can be suit the capacity of the project site and define the number of each building types. In the defining process, it supports user in making the rapid decisions which always happen in the physical meetings. The second step is to plan the layout of the project. In this process, user can switch between 2D & 3D modes in the method of sit planning and walkthrough. The final step is to see the outcome of the software. GUI will show the feasibility of this project in pie chart (illustrate the percentage of building type area and combine with open space ratio) and graph (illustrate the payback period) and user can also edit the entire input that was made in the very first process.

5. Conclusion

This research explores real time Hypothesis and Trial and Error methods in the housing planning project by using myMonitoring, Scratch Pad, and Virtual Reality. From the experimental results, the DSS allows designers to improve the design of the project in real time by inspecting the result of their design via the architectural design-oriented GUI called myMonitoring and Scratch Pad. The myMonitoring consists of three parts corresponding to laws, design standards and specific parameters of the project. The Scratch Pad speeds up the dividing building type number process. Moreover, the DSS also supports three dimensional interfaces as a virtual reality (VR) system for the collaborative project design.

Future work will support other kinds of project such as private housing project, Condominium, and single house or resort project then continue to the other phases of project delivery. Finally we will create more flexible, updatable software with complete database.

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