Guiding ideas for positive and economic design matching with BIM applications

Algendy Shaker and Vaclav Beran

Abstract

Recent years have witnessed a growing interest in the integration of the built environment and building cost. There is, therefore, a clear need to better integrate building cost into the sustainable design issues.
This study is a proposal for an integrated approach to reduce the building cost through customer needs. The study discusses some important basics of building costs, then explains that the idea of integration is attempting to commensurate design with cost. The main idea of this paper is to study the integrated design taking into account the economic side. This study is of an economical aspect to design strong and economical buildings and maximize the functional efficiency, especially in city centers. It suggests that such methods and techniques are based on integrated design with more attention to the economic dimension and marketing excellence.
Keywords: *Integrated Design, Economic Dimension, Building Cost, Cost Estimating, City Center*, *Building information modeling (BIM.*

1. Introduction

There are four main phases or levels of project development
1. Planning
2. Scoping
3. Design
4. Plans, Specifications, and Estimate (PS&E).

Conceptual design refers to a stage in the design procedure. This stage is the one where designers define rough part characteristics based on the part requirements (Patrick Martin et al., 2007) . The final design solution does not come all at once at the stroke of a pencil. The design process is a developmental and iterative process in which various design conflicts may need to be resolved (J. M. Zunde and Hocine Bougdah, 2006). It is important, therefore, to start redesign early during design phase as possible since any design changes that have to be made during production are usually very costly. An integrated design process brings together all of the parties that will work on a building at the beginning of the project – clients, consultants, financiers, builders, tenants etc.

2. Background

In 2006, The Swiss research center for rationalization in building and civil engineering made a study in estimating project construction costs, and proposing methods such as construction material cost and its update every year. But this method doesn't consider the differences in local prices or building type. This method requires detailed analysis for each building element; beside it doesn't give quick estimation.

Later, an intelligent suggestion was adopted to estimate the project costs in the form of a set of programs that was developed by the Swiss Federal Institute of Technology – Lausanne. The design stage is considered the most important stage in the construction process when the most effective decisions about the building structure, function, and the distribution of activities are taken. But in large projects there is always difficulty in showing the design to the clients such as the number of unit in residential projects. So the basic idea depends on the addition of some procedures and improving some methods during the design stage not in the implementation stage because there are many successful economic strategies to achieve very high quality.

3. Design loop and Integrated Design

An integrated design approach is likely to achieve better and sustainable solutions. Such an approach would consider the various constraints imposed by the brief, site and client (J. M. Zunde and Hocine Bougdah, 2006). All buildings have to achieve these basic levels of integration to some degree before they can be built and occupied. It is also obvious that different level of integration among the systems is possible and that a more highly integrated building is more likely to enjoy better degrees of fit, image, and function. But although these aspects contribute toward a better

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building, they do not inherently satisfy the notion of architecture (Leonard R. Bachman, 2003). Governmental and public organizations in many European countries are forced to continuously monitor and improve their management system driven by reduced time-to-market, increasing numbers of customer requirements, higher complexity of technology and a deeper involvement of suppliers in the product development life-cycle (K. W. Wagner et al., 2005). In any project where a new building or refurbishment is being considered, it is best achieved through an integrated design process that includes management in construction and during operation (Australian Government, 2006).

The primary barriers to an integrated design process are as follows (Prasad Vaidya et al., 2009):
a. Unfamiliarity with the process, b. Owners' expectations,
c. Perception of risk by the engineers and d. Fee structures.
There are five key principles to improve an integrated design:

- Integrating economic and environmental goals,
- The valuation principle,
- Providing for equity between generations,
- Dealing cautiously with risk and
- Recognizing the global dimension.

It possible to prepare and organize it very early and to better control. However, estimating a development project from outline **requirements** and not from a physical design (Paul C. Tinnirello, 2002).
The best way to reduce all of the economic impacts of a different buildings is to ensure that decisions are made holistically during design phase.

4. New project in Holesovice – Prague City- Czech Republic

The project area is located in Holesovice, Prague 7, Czech Republic. This project is made of many buildings with free spaces including gardens and public areas. The project is inspired by revitalization of industrial zones in Vienna, Rotterdam, London, New York and other cities. The project conception is characterized by its emphasis on building acceptance within the wider urban systems. The project is planned to be finished in 2015.

4.1 Concept

The main idea of the project depends on multi-level distribution of activities, the first level includes the garage and commercial activities while the second level houses administrative activities and the third level includes housing (flats and villas).There are some basic needs of each activity, maximize the functional efficiency (V Beran, Algendy, S, 2011).

4.2 The idea of dividing buildings in to standard units

The idea of dividing buildings into construction modules depends on establishing modular units, with each structural part consisting of one or more modular units. Each full project item is made up of these units, so that each floor of the project is a group of standard units, and each floors is a group of these units. We can calculate each space, the total space area and the frequency of these units.

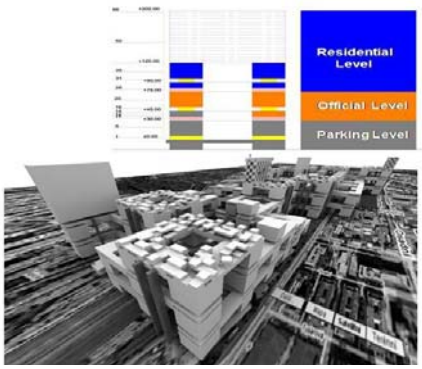

Fig. 1 The project idea depends on multi-level distribution of activities

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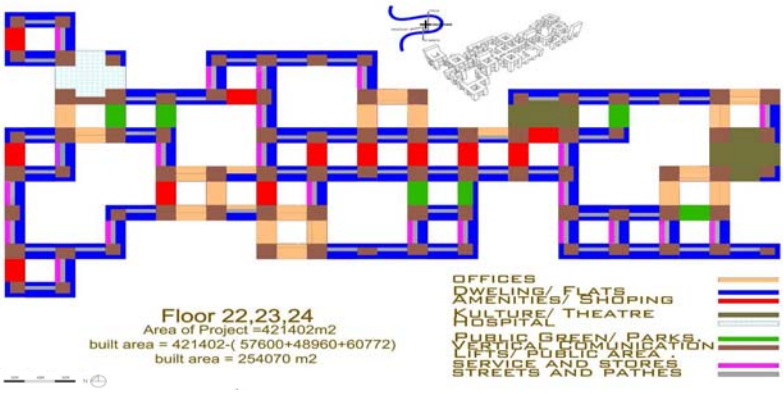

Fig. 2 Activities plan for residential floor

4.3 Methodology and Discussion

During the first phase of the project, project design, the task is split into standard units (modules). Each of these units has specific properties, both in terms of scale, composition or height for example. At this stage, the project consists of a group of units created depending on what is available, to suit the Architects designing needs and the requests of users. The next step will be introduced and marketed in multiple ways, simply relying on Visual Media and distinct consultancy offices. This will address people with all kinds of needs; whether they are residential, official, commercial or otherwise.

The requirements and needs of the people will be assembled, arranged and classified by what is found in the different types of buildings. By digital means we will introduce applications obtained and previously collected, categorized and aligned with specific qualities and contingents. These are already the 'Designer Work' and in your initial project design, when the program harmonizes, and the data obtained from actual program needs to give more people a way to arrange them in order to meet their needs.

These rankings are a result of pilot tests conducted to discover what factors will be closest to fulfilling people's needs.This means it is one of many possibilities, but probably the most suitable. An Architectural designer will then redesign, using previous results, to get a more efficient proposal. Architectural designer will then redesign using previous results to get more efficient design.

4.4 Program Structure

The problem is that major projects are submitted to a very large number of active users which creates difficulty. Therefore, the main idea is dependent on adding some actions and certain means during the architectural design, not during the implementation phase. There are many methods and policies that are sufficient to achieve high economical and efficiency success.

Firstly: the Excel program application. This step is easy because its deals with statistical information.

To view all project data through data tables described in each of these areas; project units, preparation, and its cost, it is also arranging modules and calculating size preparation. To prepare each plan in standard units, its cells make up a program where every activity is given featured colour units; these boxes are repeated and arranged like the proposed design of the architect.

Each project plan filtering comes after the analysis of the information through some means such as Pivot Table Field List and Sort & Filter.

Secondly: after the project view, it can be marketed in different ways; for example using applications like Visual Media and specialist offices to get the client's needs. This phase also requires assembling it into numbers and tables, similar to the project data of the first phase of design. This is to create a scope of data which reflects effectively the client's needs (S Algendy, 2011).

Thirdly: the difficult stage, it is challenging because it is dealing with information dynamically. It is a scientifically based way, matching Excel program figures and tables to meet the user's needs. This is to give the best units and elements arrangement. Finally the plans are rearranged to match with needs, then the architect can redesign based on the information. This allows the architect to reflect and achieve the client's actual requirements.

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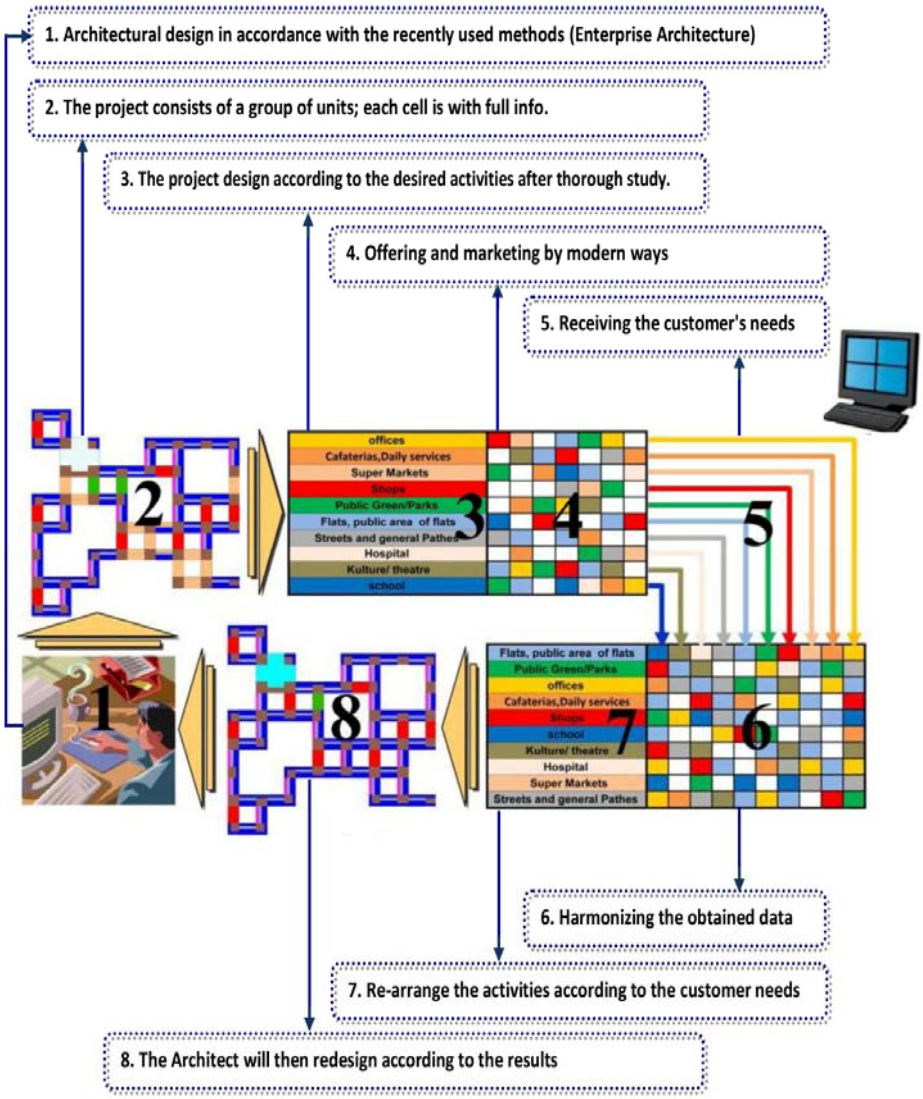

Fig. 3 Stages of idea proposed to achieve economy dependent on the development of the design phase

The case-study building provides a clear indication of the lost opportunity for capital cost saving and longer-term financial benefit. This could have been avoided or significantly reduced with application of an integrated, iterative design process.

5. Improved Architectural Design by Integration of Economic Dimension

Some designers don't give huge attention to the form of the functional building. Other methods concentrate on the form rather than the function. From the beginning of this century and the effect of the digital revolution on the construction product appeared so that it helped to improve the architect ability to innovate and obtain modern design relations in terms of mass and forms and reach new construction methods. Also it helped the architect to reach a clear design environment. The availability of the digital tools made the operations of imitation, analysis, and estimation of performance and figure much easier.

On the other hand, in modern construction systems, building management sciences and building economy as well we can notice a great launch that used the outcomes of four technological revolutions. The first of them is the appearance of the computer; the second is the appearance and spread of the international network. The third revolution is the development of informational media (INFOMEDIA), and finally the revolution of the quick and expanding information which exceeds the Internet with its modern designs, so that huge fortune and experiences were introduced to the world of construction and building management and economy. Therefore the researcher's idea for a contemporary view included architects' experience in modern design as well as the experiences of engineers of

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construction, management and economy to design economic buildings reflecting their end-users' needs and based on the fact that the best method to obtain an economical building is to be suitable with its end-users' needs. Suggested methodology by the researcher includes:

Suggested methodology by the researcher includes:

A. Integrated design.
   - Multilevel city,
   - Green city and
   - Improve skyscrapers.

B. Economic study
   - Standard units,
   - Management,
   - Recommendations and
   - Estimation systems.

C. Marketing
   - Marketing during the design Phase and
   - New marketing concept using management science.

6. Match of BIM application with the proposed method

This chapter was divided into two stages: literature review and proposal flow chart. The first step was to carry out the conceptual basis review to supply the work with information, address the following topics: history of BIM, advantages of BIM approach and how BIM can be different from CAD. The second step involved proposal work flow to achieve the economic dimension and fit the building information modeling.

6.1. Building Information Modeling "BIM"

Building information modeling (BIM) is an emerging approach to the design, analysis, and documentation of buildings. At its core, BIM is about the management of information throughout the entire life cycle of a design process, from early conceptual design through construction administration, and even into facilities management (Tatjana Dzambazova et al., 2009). It is the process of generating and managing building data during its life cycle. The role of the4D BIM is to add another new dimension of Time to the3D Space of CAD solid modeling on computer (Figure 4).

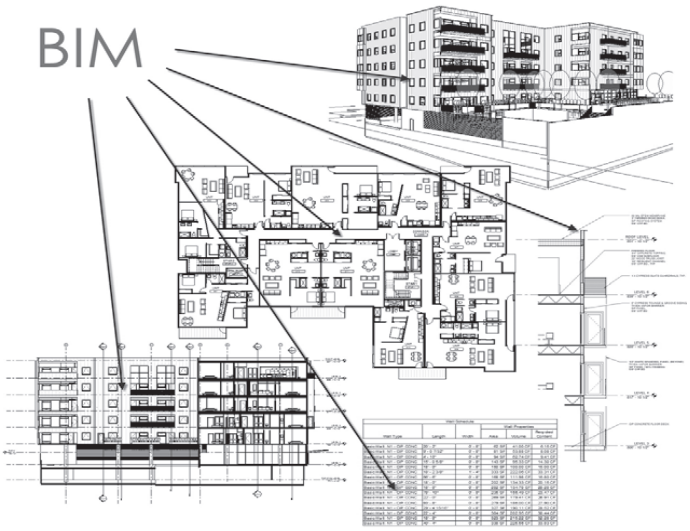

Figure 4: The role of the4D BIM is to add another new dimension of Time to the3D Space of CAD
Source: (Tatjana Dzambazova, Eddy Krygiel and Greg Demchak, 2009)

The term 4D modeling refers to the addition of the time element to the 3D model established within BIM. Typically a 4D model creates a schedule simulation that can be used by the project team and/or presented to other project stakeholders.

BIM is primarily a preconstruction tool; it is growing quickly among construction managers and contractors. The most recent McGraw-Hill Smart Market Report found that "71% of contractors report positive results with the use of BIM". Finally, the report showed that contractors are adopting and using BIM more than any other group in the

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industry, increasing to 50% in 2009 from 13% in 2007 (P.E. Bradley A. Hyatt, LEED AP, 2011). In 2008there was assign and promise of BIM lays in its application the entire project team, especially in the area of improved building performance.

6.2. Advantages of a BIM approach and its practical applications

Some of the advantages are as follows (Tatjana Dzambazova, Eddy Krygiel and Greg Demchak, 2009):

- Three-dimensional design visualization improves understanding of the building and its spaces and gives you the ability to show a variety of design options to both the team and the client.
- Integrated design documents minimize errors in documentation cross-referencing and keynoting, allowing clearer, more precise documents.
- Interference checking permits you to see conflicts immediately among architectural, structural, and mechanical elements in 3D and to avoid costly errors on site.
- Automated, always up-to-date schedules of building components (like door and room-area schedules) are data-driven, and can drive data and improve the visibility of costs and quantities.
- Material quantity take-offs allow better predictability and planning.
- Sustainable strategies are easier to explore, enabling you to design better buildings and make a better world.

A building information model can be used for the following purposes (Lincoln H. Forbes and Syed M. Ahmed, 2011):

- Visualization,
- Fabrication/shop drawings,
- Automated Fabrication,
- Code reviews,
- Facilities management,
- Cost estimating,
- Construction sequencing and
- Conflict, interference and collision detection.

6.3. How can BIM be Different from CAD

The key difference between BIM and computer-aided design (CAD) is that a traditional CAD system uses many separate (usually 2D) documents to explain a building. Because these documents are created separately, there is little to no correlation or intelligent connection among them.

Here are some other significant differences between BIM and CAD (Tatjana Dzambazova, Eddy Krygiel and Greg Demchak, 2009):

- BIM adopts a task-oriented rather than an object-oriented methodology,
- BIM keeps you honest,
- BIM is more than a 3D modeller,
- BIM is a data-driven design tool and
- BIM is based on an architectural classification system, not ″layers.″
- The basis of the assignment was to create a 4D model or schedule simulation by utilizing the construction schedule established in the previous exercises (P.E. Bradley A. Hyatt, LEED AP, 2011).

6.4. BIM and Sustainable Design

BIM tools facilitate sustainable design. They provide for (Lincoln H. Forbes and Syed M. Ahmed, 2011):

- Structural design analysis (Figure 5).
- Energy analysis,
- Day lighting and lighting analysis,
- Model viewing tools for design review,
- Material database,
- Database tools for construction management,
- Database tools for facility management (Figure 6) and

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- Monitoring and controls.

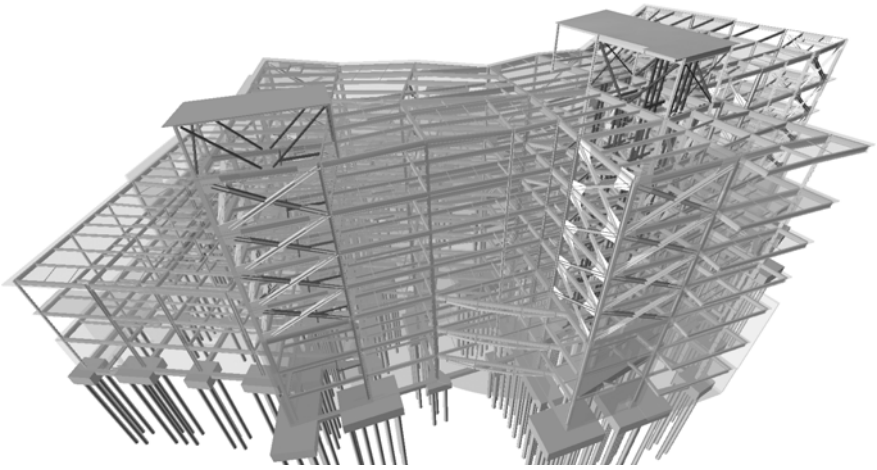

Figure 5: Final structural design model is one of BIM tools facilitate sustainable design.
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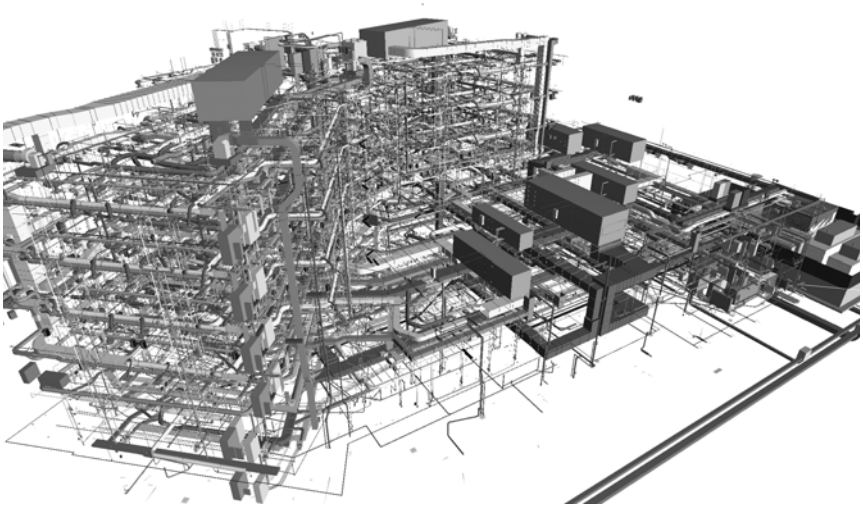

Figure 6: Model of all mechanical and fire protection system is one of BIM tools.
Source: (Charles M. Eastman, 2011)

6.5. BIM system

It is a software system that incorporates a BIM design application and other applications that utilize the BIM data. The system may be connected through a local area network or the Internet (Charles M. Eastman, 2011). Building information modeling (BIM) is an emerging tool in the design industry that is used to design and document a project, but is also used as a vehicle to enhance communication among all the project stakeholders. This tool, not only has already begun changing the way of designers' work with their consultants and with builders, but also it has the ability to help guiding the industry in a more sustainable direction by allowing easier access to the necessary tools to quantify a greener design approach (Eddy Krygiel and Brad Nies, 2008).

6.6. Proposal Work Flow to Achieve the Economic Dimension and Fit the Building Information Modeling (BIM)

The customer shows interest in one of the designs, the presentation tier delegates a call to the Design Service to retrieve the required Design. When the customer needs some changes in the existing design, s/he submits a request with the new requirements. Designers receive new requirements and design change request, then call the Design Analyzer to load the design matrix from the Repository layer (database). Designer passes the digital design (design matrix) along with the new requirements to the Unit Locator to find the best location for the new requirement in the existing design. A new matrix will be generated, and through the Design Analyzer, the Visual Design is returned (Figure 7).

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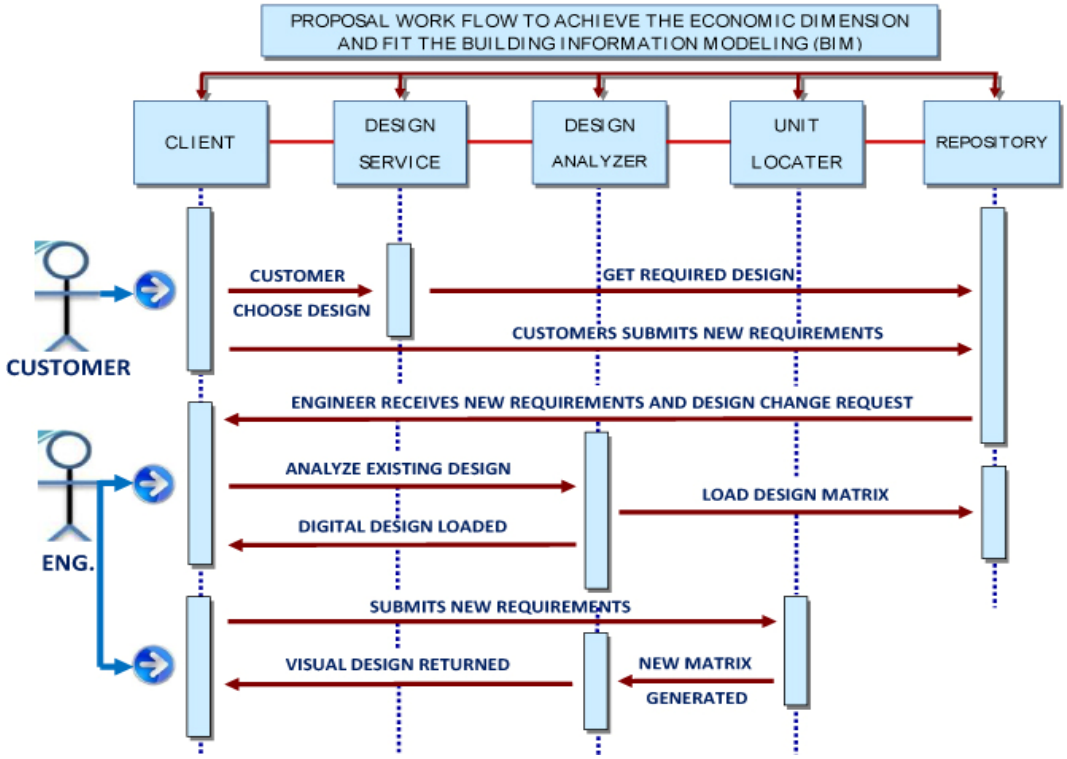

Figure 7: Proposal work flow to achieve the economic dimension

This study provides a feasible structure to take advantage of current technologies to improve architectural design without losing the advantages of this design. We use the proposed approach, starting the modern architectural design, and then applying the available ideas and techniques in the above-mentioned economic study such as: The Excel program application, marketing and rearranging the plans to match with the required needs, and then redesigning based on the new information, and then we are going to send this information to the database. This is a direct transfer of information to anew matrix, which leads to the visual design that can be illustrated by the proposed workflow.

7. CONCLUSION

This study discusses some visions to get an integrated economical design using ideas that have been studied and presented in previous researches. This idea offers solutions for many problems of modern skyscrapers. It includes several advantages of modern design as well. The researcher has pointed out that the best way to obtain an economical building is to make a design that corresponds with the customer's need.

One of these visions is to use the economists' experience in economics and marketing to help in the management of buildings and establishing more economical systems. Another vision to get an integrated economical design is to use the modern methods of marketing to improve the design by exploring the public ideas and discovering the customer's need, then converting this information to an architectural design so that the final design will be the closest to the actual needs of the users. From the aforementioned we can confirm some important points such as:

This suggested methodology gives economic way to think through the design phase.

The greatest chance to reduce the economic impact of a building is to tackle the minimization of impacts at the design stage, through economic guidance during design.

The design standards need to be recorded and fed back into the design loop.

It is important, therefore, to start redesign early during design phase as possible since any design changes that have to be made during production are usually very costly.

This is a proposed way to keep the design idea and to keep a number of considerations, additionally; there were many positive recommendations for future improvements for this program. Some of these results and recommendations following:

- BIM is helpful with solutions of this study,

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- Formally, BIM is defined as the parametric modeling of a building. Simply stated BIM allows the project team to virtually design and construct the building. BIM is not only a technological innovation, but also a significant shift in the overall design process,
- These benefits of 4D modeling greatly increase the construction manager's ability to plan and schedule a construction project,
- After extrapolation for many of the references that describe BIM system, the method that was followed in the design and the economic study are commensurate with this technique and it is easy to get great results in a very short time,
- The use of 4D modeling technology with the vision researcher allows project teams to visualize construction plans and improves the communication within the team,
- Researcher asserts that the proposed approach increases the ability of the architect to add more specifications to the project not just as textual description,
- This study about proposal work flow should not be limited , but needs to develop and study more accurately and deeply and
- The researcher is already in contact with one of the major programming companies in Germany that confirmed that the model is applicable

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