

# The Potential to Develop Design Quality Automation of Residential Housing

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**Abstract**— The applications of planning and design solutions are cradle for the building defects and maintenance issues related with design faults of the built environment. Maintenance that emerges from deficient design indicates that the building design has not been conceded in perception of building maintenance. Reviewing the nature of deficient design and resulting maintenance problems in various built forms reveals that housing sector is most effective of this phenomenon. The reason can be set as since all the population of world is living in some form of shelter/enclosure called house. Adoption of the information technology (IT) standard has not only heightened the need for IT knowledge but also extend the capabilities of many designers/architects and builders. Therefore there is niche to develop an integrated hub that could regulate the function of each professional involved in building processes. This paper will look into the prospectus to develop the automated monitoring system to check the performance of low and medium cost housing. Furthermore this paper will also highlights the stages of research to accomplish integrated monitoring system for housing performance. In the last section of paper it would be justified that integrated monitoring system could be considered as the problem solving scheme to attain the rational solution to check the housing performance and quality at post occupational stage, particularly in developing regions.

**Keywords**— Housing Performance, Design Quality, Information Technology, Post Occupational Defects & Maintenance.

## I. INTRODUCTION

**U**NDER developing countries those are experiencing rapid industrial growth are striving hard to prevent themselves from being swallowed by the big economies. This trend of underdeveloped nations results in unplanned growth, development and law transient in almost all walks of life particularly in urban centers. Alarming rate of population growth is another problem faced by these countries which ultimately creates the demand for increased number of housing facilities. In modern days house is a basic icon of shelter where man can plan to live and work under a protected environment.

United Nations (1992) mentions in report that it is estimated that world has crossed a demographic milestone, i.e. for the

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first time in the history of mankind the urban population is more than the rural population. However study of World Bank suggests that urbanization and resulting housing problems are the most dominant phenomenon in all developing countries is inevitable, since it is directly linked with their economic growth. But facts indicated that urban population forms an overwhelming majority in all developed countries, (World Bank, 1990).

House or its multiple form housing has remained subject of research and discussion on number of reputable platforms and around the globe the importance of housing has increased many folds and still it is growing with every day past. This fact gain more momentum when the state of housing in developing nations is taken into account. Report of World Bank (1993) reveals that larger faction of population living in third world has a little access of quality housing.

The issue of housing and its design is pronounced by Chowdhury (1985) as design of the house is one of the most difficult tasks in the field of architecture. A proper understanding of the nature of human needs is of crucial importance in the formulation of houses and space standards. And regarding the importance of function in shelter/house, he further stressed that, a shelter provides people with functional, social and spiritual needs. The life of an individual and family unfolds in the space within shelter. Any attempt at formulating housing and space standards should start from recognizing the quality of space that has to be provided in the family home to satisfy these needs.

In the housing sector of Third World it is worth mentioning that unlike other parts of world private sector is much more efficient than public sector in providing housing to residents. Practically all authorities on housing provision in developing countries agree that the vast majority of shelter and housing of the middle income and low income group is provided through the informal sector. However a small share of low income housing is provided through the formal channels of government and private sector. Whereas public sector housing program for low income group take the form of direct public provision of completed units, aided self help program and settlement upgrading (Okpala, 1992).

Discussion above reveals that there is a need to improve the quality of housing design in developing region and also there is a niche for developing parallel system to monitor the quality of design. Study of Chakrabarty (2007) describe that, urban development entails huge consumptions of resources (money, materials, land, energy etc.) which are always inadequate in

compare to need. Hence productive use of such resource is possible by adopting an integrated management approach. This approach is essential for resource efficient and equitable solution of quality housing and other urban problems. The need of potential problem solving program capable to meets the specified criteria and promise the better design quality thus making the computer use indispensable.

Regarding housing design and building process of individual houses Kowaltowski *et.al* (2005), mentions that, most of sketch lack technical design qualities and are not adapted specifically to owner lot condition. Houses are mostly built without prior planning of functional aspects which can hinder housing quality. Another study of Kowaltowasi *et.al* (1998), highlights the issues of housing design and to overcome the shortcomings of design standards the study insist the use of architectural design tool called Automet. The process of program begins in CAD program with dialogue box and characterization of the house design, according to family size and capable to accommodate special desires also.

The above discussion of housing in under developing and existing automation system aligned with various aspect of building design can be summarized as, the private sector is largely responsible for providing housing in developing countries and its existing state suggests that it is an important issue that needs further research. The matter needs more brainstorming for improvement of housing design and quality construction in developing countries. And there is need to develop/introduce the automation system to ascertain the quality of design at post occupational stage.

## II. LITERATURE REVIEW

By developing an understanding for issues mentioned by researchers, organizations and expertise of field in above paragraphs it is revealed that lack of housing is not only mounting pressure on available housing but also the ever growing housing demand in developing regions have paved the track for improper/faulty design and construction.

Faulty design and its effects on the house/building maintenance has remained neglected part in field of research, modern society and especially in underdeveloped nations. This mentioned issue of research can be understood in terms of Architectural Eco System. Whenever designer completes the project was not fully aware of consequences of their design. Only through post occupational survey designer usually realize that what mistakes or bad decision they have taken during design process. And those decisions mostly emerged in form of certain types of defects in building. Unfortunately such unforeseen conditions are the part of daily life for end user of residential buildings of low medium cost housing. There are two purpose of this research; one is to understand and identify the causes of faulty design and their effects on residential buildings and second to develop integrated system to judge these defects before paying for them.

In this perspective Seeley (1987) adds that, design team frequently neglects the consideration of maintenance aspects and there is great need to reduce the gap between design and maintenance. Seeley identified the problem of design and

maintenance as the gulf between design and maintenance. Conceivably Seeley stress that maintenance is important issue to be consider right from the design stage to prevent its unplanned reappearance at post occupational stage of building, which could be more implicating and affecting on the building. But how this gap could be reduced, the answer may be found in developing understanding for design and maintenance in the light of definition given by the Royal Institution of Chartered Surveyors (RICS) that building design should be considered as the design of the autos. The autos are usually provided with schedule of planned and emergency manual, thus it could be recommended that one way to reduce the gap between the maintenance and design is to provide the residents with manual of house/building design and product used in that design.

The caption of this research has gained certain momentum and attracts good number of researchers to address the similar problem in other parts of globe and they have highlighted the vitality of topic through their publications and also developed a reliable link between the Design and Maintenance issues. One of the researchers has recorded his views as; design plays a major role in determining the conditions of the building after completion, mainly in aspects of defects and maintenance (Ahmad, 2006). The research further stress that, indirectly design influences the performance and physical characteristic of building and its durability to with stand against environmental condition, social interfaces such as graffiti and vandalism. Therefore the link between design and maintenance should not only seen from the point of increasing the repair work or cost involve, but it need to consider also the impact of design on structure and material installed as well as the life cycle of each component of building.

Recording his view about using computer based knowledge for improvement of design quality Mitchell (1977), mention that architectural design can be viewed as special kind of problem solving processes involving search through alternative states to discover a state that meets certain specific criteria. Mitchell further stresses that planning and design of housing/building/urban services could be aligned with computation resource to obtain affordable design. The study further reveals that such objectives can be resolved through *Generative System*, which is an answer to variety of potential solution. Mitchell concluded with remarks that a design problem can be characterized in term of data structure, constraints, objectives and a solution generating to produce a potential solution for consideration. However a computer can be used in the design process to store and retrieve data describing a design to test the potential solution for the set goals, and to automatically generate solution to well defined problems. Study also recommends that, in case a computer is used as an automated design synthesis machine, it supplement some of the traditional function of designer.

The discussion above presents two aspects of building design deficiency, First the importance of automation in design and construction industry is need of this contemporary time. And it unfortunate that in spite of availability of modern highly powerful computers systems, optimization is rarely applied to in our modern building and housing. This lacking causing many imbalances and deficiency with subsequent design faults in building.

Second, it is need of time to ponder the design process and construction process at various stages i.e. from 2D drawings to application of outer fabric and skin to façade. Such measures will not only prevent the building from highly taxed maintenance but also multiply the life span of buildings.

### III. SCOPE OF STUDY

At this stage of research it is quite clear that there is strong connection between design, building defects and maintenance. However maintenance in design act as the barometer of the design quality, higher the maintenance at post occupational stage lower the quality of design. Thus design quality is inversely proportional to maintenance. The scope of study is established through summing-up the discussion in above lines. There are three major features which have been established and that dictate the scope of this study.

1. Designer and owners have long term view of their building life cycle but designs are always coupled with defects, causing maintenance.
2. Developer offers dynamic solutions that are interoperable with buildings but in fact end user can not test these high claims until starts living in that building.
3. Buyers and users are vulnerable in property retail market and plat form is required to safe their interest, optimum reliability, comfort and to secure their investment in shape of built assets.

### IV. NEED OF AUTOMATION

Advocating the need of automated system and its induction at various aspects and levels of daily life, Jackson (1999) has concluded with three reasons to adopt the automation system,

1. Expertise of human is perishable, however computer expertise are permanent.
2. Human expertise are difficult to transfer, whereas computer based knowledge and expertise can be shared and transfer easily.
3. Human expertise is very expensive.

Literature review reveals that residential buildings are most volatile regions to conduct research, since they are subject to constant usage. It is quite clear that under-developed regions are not only regions infected by the issues of faulty building design but developed regions are also under the heavy burden of similar issues.

The design/building industry is using some automated modules for building design related to various stages of design i.e. from design to construction. Following are the few examples of such automated modules for building design being produced and used in industry.

#### *Example: 1*

An automated building element selection system developed by Halil & Mesut (2004). The system is responsible for selection of building elements correctly from vast number of alternatives in design process. According to claims of this system, it is capable to choose the right building element to

avoid the serious problems concerned with economy, construction functionality and appearance.

#### *Example: 2*

Rivard *et.al* (1999), proposed a shared conceptual model for building envelope design process, in order to provide communication between different members of building design team.

#### *Example: 3*

Altunay (2001), proposed a model for selection of internal finishes. This model handles floor coverings materials made of wood, stone, ceramic, metal, concrete, plastic, carpet, partition wall, plastering, and paintings. The factors considers in this program are strength, durability, maintenance, ergonomics and aesthetics, etc. The user of the system established the weight of importance for each factor and the system integrates this input with knowledge and proposes some material with highest score.

### V. PROBLEM STATEMENT

Architecture of building is directly concerned with the proper performance of building although it is usually achieved through considering various aspects regarding site, people and planning. But poor design is another side of this picture and it appears when owner, builder, even architect sometimes fails to understand the consequences of their design and building strategies and that gives birth to faulty design or architecture. It is like an architectural eco system when we fail to implement or disturb the due course of design it results in undesired spaces and planning features. And situation becomes worst when such features start affecting the functions of building and ignite the engine of maintenance.

Advance levels of automation, integration of system and a new generation of efficient and intelligent hardware bring real advantages that can influence to make buildings business more productive and promising. A deficient design of house coupled with design faults can result in dump building that cannot provide the promised comfort and secured savings. In this due course of housing retail there is niche to implement intelligent system which can assist the user about design quality of individual /grouped house.

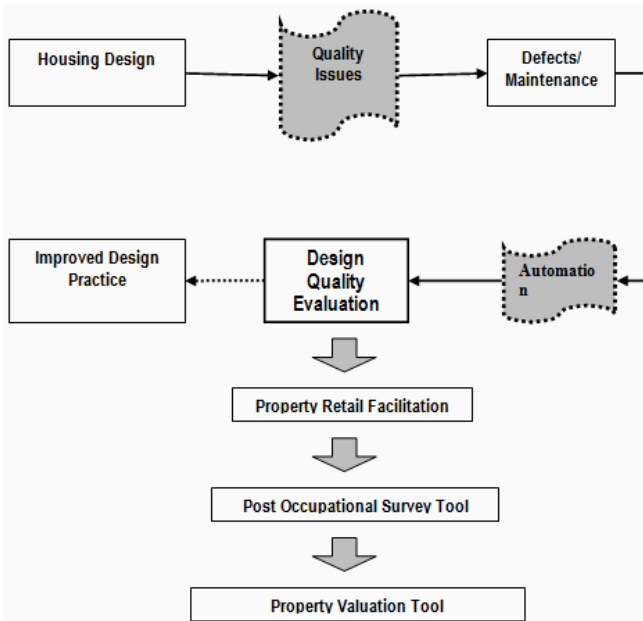


Fig. 1: Conceptual Model of Research Path *Source: Author*

VI. AIM OF RESEARCH

The aim of studies is to primarily emphasis on generation of computation system to judge the quality of design through the processes of identifying the design issues influencing and developing the concept of inferior design in residential buildings.

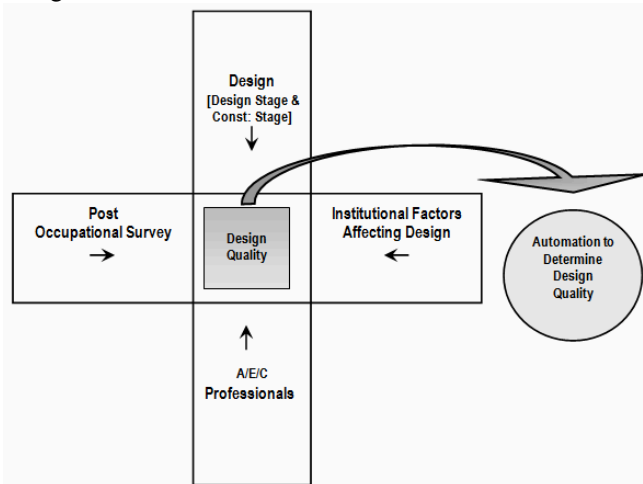


Fig. 2: Conceptual Model for Research Base. *Source: Author*

VII. RESEARCH METHODOLOGY

A. Stages of Research

In order to achieve the objectives of this study the methodology of research is resolved through four stages, as shown in Figure 3. The brief discussion of each stage is given below.

Stage I

In this stage data was collected through both primary and secondary data collection methods. Through extensive literature review related to field of study is taken into consideration and it covers the different areas related to objectives of this study. The outcome of practice will be accumulated in form of initial and final questionnaires. During the literature review understanding for the study and its issues will be developed in light of design, defects and maintenance.

At this stage research problem is also workout through evaluating the existing condition of site and literature review. Intense literature review at this stage also facilitates to recognize and locate the global existence of research problem. Continuing with literature review also reveals the existing practice in the design and construction. During the progression of broad literature review, relevant textbooks, paper, and technical reports are taken into account and organized. Discussions with professional personnel such as architects, engineers, building maintenance contractors, project managers, and designer’s are assimilated to consolidate the research ideas.

Stage II

Stage II will produce a pilot study and it is propose to carry out through questionnaire survey. The data will be collected to analyze the significance of faulty design and issues of design deficiencies at site. The design of questionnaire survey form will base on the issues of existing condition of residential built form, design and construction practice.

Stage III

Stage III will carry out to identify the issues of faulty design and their causes. The analysis of pilot survey shall pave the way for the continuation of the study at micro level. Parallel to this survey, comparative study will also carry out at selected sites of low and medium cost housing. These case studies will be conducted with aim to evaluate the implications of design faults.

Stage IV

Fourth stage of the research is responsible to accomplish two important task of this research. First is data analysis and draft findings inform of data interpretation. Second is to work out feedback from literature review, data interpretation, and discussion from professionals will be incorporated to formulate the recommendation for first sketch for automation.

Stage V

This final stage is attributed to cram all analysis and findings in systematic schedule to map the software for evaluation of design quality. At this stage researcher will also work closely with software developer/architect for development of user’s friendly software for design quality evaluation. This stage is further divided into following sub sections

B. Database Design

Data base design is the first step toward development of automaton to judge the design quality of housing. This process will not only allow to understand the data analysis and findings

of research and to develop the valid link between aim of research and the environment of field, in real world. The data base for this program would design in a manner that it will evolve and allow the changes to comply with forthcoming information need of design quality evaluation in housing.

According to Ricardo (1990), the data base of automation program should reflect the following features for true logical model.

1. Model should faithfully reflect the operation of organization or field.
2. Model should be flexible enough to adopt the changes for its up gradation.
3. It should accommodate the different users' views.

#### C. Data Dictionary

Preparing a data dictionary is the second step toward development of automaton to judge the design quality of housing. At this development stage all types of housing defects, their causes & implications, correlation of each defect and professionals or groups responsible for these defects, types of respondents & users will be determined. Ricardo (1990) briefs that, from this stage the data administrator will begin the development of data dictionary by identifying the data items, securing agreement from researcher on definition of each item and entering the items in dictionary.

#### D. Entity Relation (ER) Program

Entity Relation models is the second step toward development of automaton to judge the design quality of housing. Ricardo records that entity relation (ER) is developed by Chen (1981) to facilitate the database designer to express the logical properties of the database in an enterprise schema, or we can say that it is the organizational plan of data base. In fact ER is conceptual presentation of scheme of data base design. However in case o this research ER models will be prepared under the assistance of researcher to determine the placement of each quality effecting factors (entity) of housing design at right place in relation to other entities of the data.

#### E. Software Development

According to Birrell (1985) software development is “the translation of a user need”. Whereas study of McCarthy (1995) defines it as, software development encompasses the processes of software engineering combined with the research and goals of software marketing to develop computer software products. Since the aim of research is to come up user friendly software to facilitate the people and professional to evaluate the quality of housing design, therefore through this step the software will be developed. This will encompass all the collected data for the purpose of evaluation of design quality. Software will be named as *judge to evaluate the design quality of housing* and it will be developed through using the computer programming language named Open Source by using the platform of My SQL and PhP.

#### F. Implementation

Wikipedia explains that, implementation platforms are systems where the implementation is accessible. Open implementation allows developers of a program to alter pieces of the underlying software to fit their specific needs. With this technique it is far easier to write general tools. In this study there are number of entities in form of design defects, respondents, locations etc. The defects have correlation with their root causes therefore it will be needed to keep checking and altering the entities and get the specific answer for proper evaluation of housing design. Through this step of implementation the desired results will be obtained in form of successful tool of design evaluation.

#### G. Software Testing

Software testing will be the final stage towards completing the task of having software for quality evaluation housing design. Wikipedia explains software testing as the process used to help identify the correctness, completeness, security, and quality of developed computer software. Testing is a process of technical investigation, performed on behalf of stakeholders, that is intended to reveal quality-related information about the product with respect to the context in which it is intended to operate. However in order to achieve the objectives of this research, the resultant software will tested in context of location, type of housing, design defects and evaluation of design quality.

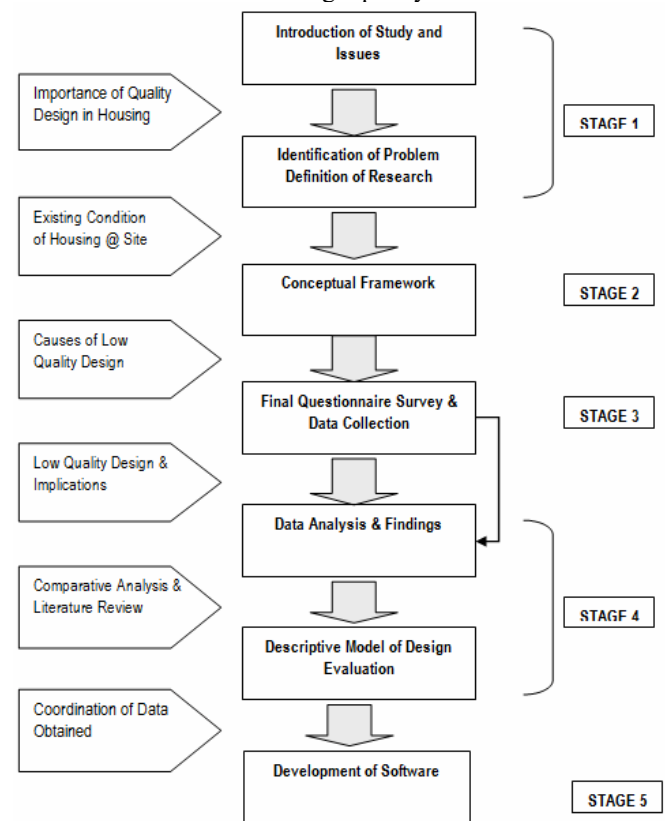


Fig. 3: Conceptual Model Research Methodology & Stages of Research  
Source: Author

## VIII. CONTRIBUTION TO FIELD

The outcomes of this research hold multi dimensional benefits for common men as well as professionals which are mentions as under, Fig 4.

1. To facilitate the common man to work out the best option for his investment in housing.
2. Provide Opportunity to Professional Surveyors to Conduct Surveys.
3. Tool for Design Community to Work out the Trends of Design Preference in Specific Region.
4. Tool for valuator to ascertain the Condition of Building for Various Purposes, e.g. Mortgage, Dilapidation Surveys etc.

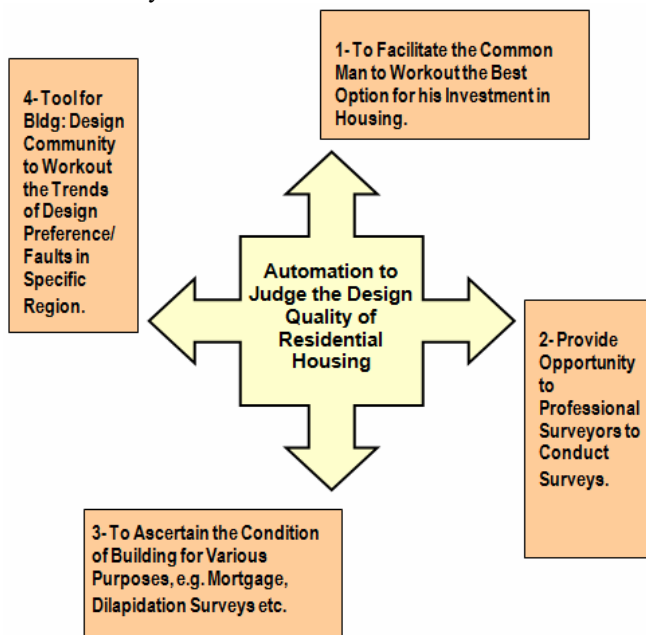


Fig. 4: Conceptual Model of Research Benefits and Outcome  
Source: Author

## IX. CONCLUSION

Thus it could be added that, a poor/faulty design is directly concerned with designer of building and construction team. And because of this public concern and confidence in both professional and a construction sector is damaged. Researchers have concluded that faulty design decisions as major cause of most common faults. Those can be identified as failure to follow well established design criteria and in the choice of structural system and materials selection etc. All these factors implicate the built forms / housing at post occupational stage and thus the daily life of users is taxed with burden with menace of maintenance.

Through this research it is proposed to develop automation system which would not only encompasses the design faults in housing forms but also enables its users to evaluate the quality of housing design available in market. This Automation would be based on faults and defects commonly found in housing design and later transformed into software with support of experts of filed. The principal researcher will work as a manger of this whole process and it is expected that final outcome of

this research shall help the common men to seek the better investment option for its life time savings.

## REFERENCES

- [1] Altunay, C.A. (2001). *Knowledge based system for alternative selection of internal finishes*. Gazi Magusa , Mersin, Turkey: Eastern Mediterranean University.
- [2] Birrell, N.D. (1985). *A Practical Handbook for Software Development*. Cambridge University Press.
- [3] Chen, P. (1980). *Proceedings of second international conference on Entity-Relationship Approach*. North Holland: December 1981.
- [4] Chakrabarty, B.K. (2007). Computer aided deigning in urban development and management. *Building & Environment* 42, (2007) 473-494.
- [5] Chowdhury, I. (1985). *Regionalism in Architecture*. Singapore: Concept Media, Agha Khan Award for Architecture.
- [6] Halil, Z. and Mesut, B. (2004). A Building Elements Selection System for Architects, *Building and Environment* 39 (2004) 307 – 316.
- [7] Jackson, P. (1999). *Introduction To Expert System*. England: Addison-Wesley.
- [8] Kowaltowaski, D.C.C.K., Silva, A., Pina, M.G., and Ruschel, C.R.(2005). A house design assiatance for slef building process of the region Campinas, Barzil. *Habitat International*, 29, 2005, 95-1 11.
- [9] Mitchell, W.J. (1977). *Computer Aided Architectural Design*. New York: Pertocelli Charters 1977.
- [10] McCarthy, J. (1995). *Dynamics of Software Development*. August 1, 1995, pp:1 0-30. Okpala, D.C.I. (1992). Housing Production & Technology in Developing Countries. *Habitat International*, 16 (3) pp 9-31.
- [11] Rivard, H., Bedard, C. and Fazio, P.(1999). Shaped conceptual model for building envelope design process. *Building and Environment*, 34, 1999.
- [12] Ramly, A. (2006). Link between Design and Maintenance, *Building Engineers*, Vol 81, No 5, May 2006.
- [13] RICS (1990). *Practice Note 4 on Building Planned Maintenance*. London UK: Royal Institute of Chartered Surveyors.
- [14] Ricardo, C. (1990). *Data Based Systems*. New York: Macmillan Publishing Company.
- [15] Seeley, I.H. (1987). *Building Maintenance*, New York: Palgrove Publication.
- [16] United Nations. (1992). *World Population Trend*. New York: Population Division United Nations.
- [17] World Bank. (1993). *Housing, Enabling Market to Work*, Washington D.C: World Bank.
- [18] World Bank. (1990). *World Development Report*. Washington D.C: World Bank.