

THE CONSIDERATION OF LIFELONG OWNER'S AND PROPERTY'S CHARACTERISTICS IN ND CAD SYSTEM

The case of affordable housing in kingdom of Saudi Arabia

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Abstract. Residential property value is affected by several factors during its useful time. . These factors include people's lifestyles, traditions and culture, and the way they live and interact with the built environment. The property characteristics such as its location, building quality, adaptability, and energy efficiency would also have an impact on the property value. On the other hand, the nD CAD research that emerged in the late 1990s proposed endless dimensions of CAD modelling that would incorporate the building regulations' requirements, basic user needs and client requirements. However, there is a need to implement lifelong parameters that would have significant effect on the property value in 3D models during the early stages of design. This can be done through a knowledge base integrated into a 3D model and links the lifelong property's and the user's characteristics with the property's value. A survey was carried out on banks and Real Estate Development Fund (REDF) in the Kingdom of Saudi Arabia to find out the level of impact of lifelong users and property characteristics on the property's value. The results of the survey showed a number of lifelong property and user driven parameters that may have major impact on the property's value. The implementation of lifelong parameters in nD CAD models would have a number of benefits. It would provide the decision makers such as banks and investors with a tool to assess the level of impact of possible lifelong factors on the property value and consider alternative schemes. Designers would use it during the early stages of design to produce optimum design solutions that provide an adequate product that is evaluated regarding its lifelong value to the end users. Eventually it would provide a comfortable environment that is tailored to the user's needs and aspirations, while reserving the property's lifelong value.

1. Introduction

Architecture is the art of designing buildings that respond effectively to the environment and to people requirements and how they like to live. This would include the way that an individual uses the building, his/ her pattern of living, social relations, communications and entertainment. The incorporation of knowledge about people's present and future needs in the design process is vital as it would help to create a humane, sustainable, and optimum product and address people real needs and aspirations.

The increasing complexity of design of buildings and the high level of detailed information that should be incorporated in the building design has influenced how the building's design information is created, modelled and communicated. Throughout the past decades, the use of CAD has extended from 3D CAD models that represent the physical features of a building and would be used for visualization and walkthrough to 4D which can simulate the progress of the project construction process in real time. This helps project team members to foresee any construction problem that would occur during the construction stage (Broekmaat et al 2003). The design of modern buildings requires an input of multiple, and often conflicting, design perspectives such as acoustics, accessibility, maintainability, sustainability, energy, crime etc. Researchers at University of Salford have assigned various parameters to CAD models so these models can simulate people accessibility; energy, acoustic, and safety. The examination of these concepts during the early design stage would help the designer tailor the design and produce a sustainable and quality product. The aim of the present theme of nD CAD research is to respond effectively to client needs (e.g. a housing developer or a residential building's owner) in regards to the building regulations and guidelines. This paper however, highlights the need to incorporate other factors namely; the home owner and property characteristics that have a significant impact on the property lifelong value. This may secure the property value throughout its life. The owner characteristics can be categorized broadly into: the style of ownership, use, management; and control. The property characteristics would include Building quality, adaptability and energy efficiency. The research suggests these characteristics should be an integral part of the future nD CAD system and embedded as properties in spaces and building elements.

In the following sections, this paper discusses the importance of various aspects of the user's and property's characteristics and why these aspects should be implemented in the future nD CAD system. Such implementation would facilitate not only multi criteria assessment and decision-making but also participation of the end user, investors and stockholders in the design process, which would benefit the design product, and process. The proposed nD CAD system adopts IFC (Industry Foundation Classes) concept that

represents not only the elements of 3D architectural models but also abstract concepts such as schedules, activities, spaces, organization etc in the form of entities. The IFC hierarchy would allow the translation of the user/property characteristics into parameters that are attached to each element of the building.

2. Impacts on the property value

2.1. THE IMPACT OF OWNER/ USER RIGHTS ON PROPERTY VALUE

The property's ownership and control/ management rights in Saudi Arabia are partially derived from the old European building laws. The government authorities (e.g. local municipalities) set general guidelines in regards to the home owner rights to build and/or alter a property.. It certifies what designers should do regarding the building setback distances, distance between properties, block's height restrictions and so on. It does not –for instance- define how the property should be designed in regards to the local lifestyle, traditions and norms or how the user should maintain the property. This issue has been largely tackled by the Islamic Sharria which defines the home owner/ user rights and responsibilities regarding the property. Akbar (1992) pointed out three broad types of these rights/ responsibilities of an individual (i.e. the user or the owner), and these are: control and; management, ownership, and use: this includes right of use and right of benefit.

The above rights can be categorized into one of the following eight sub categories (see Table 1). The owner of the property may have three rights: ownership, control and use. He can assign one of these rights to a third party such as the use or the control. The user may have a control right or control and use rights together. A third party such as facilities' management company would have control right only. The property ownership or/and control rights can be transferred partially or wholly from the original owner to other owners and/or controllers (e.g. property managers). This possible dynamic and flexible transfer of the property rights throughout its life would have some consequences on the property value as the responsibility of use, maintenance or control would be exercised by a group of people or an individual.

TABLE 1: The rights of an individual or a party in a property

Individual or party	The owner	The user, occupant or a third party	The controller /facilities manager
1. Ownership, control	X		
2. Ownership and	X		
3. Ownership and use	X		
4. Control and use		X	
5. Ownership only	X		
6. Control only			X
7. Use only		X	
8. Right of benefit only		X	

This implicates responsibility upon each one who has one of the above rights in terms what he/she should do/not do and how it should be done. For instance, the home owner is responsible to keep up the property in a good condition. In case he/she decides to alter the property, this should be done without harming neighbours and violating their rights¹. The user/ occupant is responsible of keeping the property tidy and well maintained and to report any problems to the owner. The property facilities manager should keep the property and its systems well maintained.

A number of studies have highlighted the relation between the user characteristics, housing design and use and pointed out the importance of building up a knowledge that would be used in housing design to provide tailored design solution to people needs, lifestyle and future preferences (Hillier 1984, 1996, Hojrup 2003, Habraken 2003, and Salama 2006). In the Kingdom of Saudi Arabia, researchers mentioned that non-consideration of

¹ Ahmed and Parry highlighted how an owner/ user right should be practised without violating the neighbours' rights. They surveyed the low income housing in Cairo and noticed that despite some disadvantages that exit in the low-income housing in Cairo, residents cooperate with their neighbours upon making decisions regarding alterations of their properties or building new blocks. These residents were able to reach to the best solution that would satisfy everyone. The researchers found that such corporation is motivated by local people's beliefs and principals such as 'No Harm' principal which is derived from the Islamic values (Ahmed K G and Parry C M 2001, 2002)

user needs such as: the need for flexibility and adaptability in design has created an uncomfortable environment to the property's owner (Al-Kurdi 2002, Darweesh 2003). The absence of these aspects has enforced the owner to carry out a number of changes to their properties which are sometimes expensive to adapt it to suite their lifestyle and habits. The design of affordable housing should accommodate the owner/ user rights and changes in their lifestyle and rights during the property's life. The responsibilities and rights of each party – the user, the owner and the facilities manager-should be clearly defined to ensure the property would be properly run and managed during the property's life. The bad or ill-defined practice of these responsibilities would harm the property and may bring down its' value. Sayce (2004) discussed this issue and highlighted a number of user characteristics such as the impact of the occupier and the occupier's satisfaction with the property on the property value.

2.2. ENVIRONMENTAL AND PROPERTY CHARACTERISTICS IMPACTS ON THE PROPERTY'S VALUE

Environmental impacts triggered by climate change will lead to rising global temperatures, rising sea levels and increased frequency and intensity of extreme weather such as floods and strong winds. Natural disasters would be more frequent as well. In hot regions such as in the KSA, the rise of temperature would lead people to use air conditioning more frequently and this would in turn increase carbon dioxide emissions and increase the annual energy bill. In the future, properties may deteriorate faster and their systems may collapse or fail quicker. The properties will be costly to run if they do not interact naturally with the environment.

The incorporation of environmental impacts in the assessment of the property value has been researched by a number of researchers (Myers et al 2007). Sayce et al (2004) suggested a link between the property value and sustainability indicators. The target of this link is to attract several parties such as investors', local authorities and occupiers' attention to the importance of sustainability on property value. Sayce et al (2004) created an appraisal model that incorporates the sustainability indicators (i.e. building flexibility, energy efficiency, transport, pollutants, location, occupier, ecology and design) into calculations of property value. The impact of each indicator on property value was done through changes in the allowances made for each of the property appraisal criterions². By linking each of the

² Rental growth: the parameters developed for rental growth assume a direct relationship between rent and occupier costs; any increase in occupier costs will reduce the amount available for rent.

Rental depreciation is commonly used by appraisers to reflect refurbishment costs.

sustainability indicators with one or more of these criteria it is possible to translate the sustainability of a property into an impact on value (see Table 2). She pointed out that a range of sustainability issues should be considered by the investor or occupier who wishes to mitigate the risks represented by increasingly stringent environmental legislation, energy efficiency regulation and transport management policies operating at local, regional and national levels.

TABLE 2, links between sustainability criteria and worth (source: Sayce 2004)

Sustainability factor	Conduit (i.e. property appreciable criterion)
Building adaptability	Risk premium, cash flow, rental growth, depreciation
Accessibility	Rental growth, depreciation
Building quality	Cash flow, rental growth, depreciation
Energy efficiency	Risk premium, cash flow, rental growth, depreciation
Pollutants	Risk premium, cash flow, rental growth, depreciation
Contextual fit	Rental growth
Waste and water	Cash flow, rental growth, depreciation
Occupier satisfaction	Risk premium
Occupier impact	Risk premium

Sayce et al (2004) highlighted that a building that can not be easily adapted to support the changing needs of its user, compared with other buildings within its class, will suffer relatively rapid depreciation; as utility falls willingness/ability to pay rent will also fall. A building that is not sufficiently adaptable for its existing use type (within use) may be sufficiently adaptable to move to another use (across use) making it more sustainable than one which can not. In practical terms a building without sufficient adaptability within use will require sooner - and potentially more frequent- re-letting and refurbishment, and vice versa. This will reduce cash flow by increasing voids and refurbishment costs. Increasing an occupants' degree of control over their environment would increase the level of comfort and perceived productivity. This increased tolerance, particularly when

Cashflow: in some instances a sustainability factor may impact directly through the cashflow. This will normally be due to a requirement for a one off or series of cash payments to insure against or mitigate a potential risk. Where this is the case, assuming the cost can be accurately estimated, a figure can simply be deducted from the cashflow at the appropriate point.

Risk: such as business and investment risk. These criteria are calculated over a number of years (Sayce, 2003)

integrated with other building fabric design strategies, can enhance the adaptive potential of a building to climate change (Sayce et al 2004).

Accordingly, Steemers (2003) highlighted the importance of frequent maintenance of a building. He stated that a normal building would need the following frequent maintenance to be carried out:

- Redecorate: less than five years for redecoration which may include improved finishes or making-good superficial damage
- Refit: 7-15 years for systems and appliances which could enable improved controls and environmental performance
- Refurbish: 15-50 years for non-structural building fabric roof, wall cladding, windows, joinery and insulation could be upgraded to higher tolerance level
- Rebuild: more than 50 years for rebuilding of structural elements to higher specifications e.g. wind loading, raised floors to avoid flooding, etc.

This is provided that the building is designed and constructed according to national/ International standards such as ISO and BS standards. The Kingdom of Saudi Arabia still does not have a building code nor standards³. The design and construction of affordable homes is below the international standards and it houses large families or - in other words- is overcrowded (Al-Shaikh 2000). This would decrease the service life for various components of the home and the management and maintenance cost⁴. As a conclusion, the property value would be affected by the following issues:

a. The owner/ user characteristics: these would include:

- the lifestyle of the owner/ user that affect the way that he/ she uses and manages the property;
- the way the ownership, control and use rights are exercised by a party or a number of parties and how each party conduct his responsibilities;
- the characteristics of each party that has certain rights in the property; and
- the transfer of one of the rights to a third party

b. The property characteristics and these would include:

- the adaptability and accessibility, maintainability degree of the property
- the quality of the property

³ This is apart of very large companies in KSA such as Aramco and Royal Commission of Jubail as each of them has developed it's own building code and standards.

⁴ Struyk (2005) mentioned that a significant share of the housing stock in Saudi Arabia would need replacement in the next 20–25 years and around 30% requires improvement in the next 5 years

- the sustainability level of the property

This research suggests that these characteristics should be considered at the early stages of design and implemented in housing design by architects. Thus, the design solutions would be evaluated by designers in collaboration with financial organizations, stockholders and end owners/ users to see which design scenario has the capability of addressing these characteristics meanwhile reserving the property value.

3. The field study results

Eleven Banks and Real Estate Development Fund (REDF) in Kingdom of Saudi Arabia were surveyed in March & August 2008 to find out property and user/ owner characteristics that have significant impacts on affordable property value⁵. Banks were asked about the significance rank of a number of management and ownership factors to the affordable property value during the repayment period of the mortgage loan⁶. Banks considered a number of factors would have a weight above average (i.e. 5) and these are: building adaptability, the owner/ occupant daily lifestyle activities, energy efficiency of the property, internal and external alterations carried out by the owner to suit his/her lifestyle, maintenance and management practice style of the property by the owner, building quality and other criterion (see Table 3). Some of these factors (i.e. 5, 7, 11 & 12, see Table 3) are found also by Sayce (2003) as significant factors that would affect the property value.

4. The incorporation of user characteristics in nD CAD model.

4.1. ND CAD MODEL ARCHITECTURE

Researchers at University of Salford defined nD CAD as an extension of the building information model, which incorporates multi aspects of design information required at each stage of the lifecycle of a building facility. The nD CAD system aims to integrate a number of design dimensions or information into a holistic model, thus enabling designers to portray and visually project the building design over its complete lifecycle (Lee et al, 2003). The nD CAD modelling system is based upon the building

⁵ The questionnaire survey was conducted in March 2008 and the discussion forum was held in August 2008 respectively

⁶ Four banks set the maximum period of the repayment of mortgage loan as more than 25 years and the rest of banks (i.e. 8 banks) set the period as less than 25 years (Sidawi 2009)

information model (BIM)⁷. A BIM is a computer model database of building design information, which may also contain information about the building's construction, management, operations and maintenance (Graphisoft 2003).

TABLE 3: The weight of each of property characteristics and owner rights on the property value during the repayment period of the mortgage loan (*weight above average is in bold*)

Property characterises and owner's rights	Weighting out of 10
1. Partial transfer of the ownership	0.17
2. The transfer of right to benefit to a third party	2.83
3. Commercial investment in the property by owner	3.00
4. Management of the property by a third party	4.00
5. Building adaptability	5.27
6. The owner occupant daily lifestyle activities	5.33
7. Energy efficiency of the property	5.50
8. Internal alteration carried out by the owner to suit his lifestyle	5.83
9. Maintenance and management practice style of the property by the owner	5.83
10. External alteration carried out by the owner to suit his lifestyle (i.e. external extension)	6.36
11. Building quality	7.33
12. Other criterion (i.e. building location, age and area)	8.40

The holistic nD CAD modelling tool uses IFCs that enables good interoperability of CAD models between CAD tools. It helps to improve decision-making process and construction performance by enabling true 'what-if' analysis to be performed to demonstrate the real cost in terms of the variables of the design issues. The key feature of nD CAD system is its ability to incorporate various design perspectives in one system, and to systematically assess and compare the strengths and weaknesses of different design scenarios presented by the nD knowledge base. Aouad & Lee (2007) suggested that nD CAD prototype could be built on the concept of BIM, and is IFC-based that would include the following:

⁷ This database is constructed with intelligent 'objects' which represent building elements like walls, doors and windows. From this central database, different views of the information can be generated automatically; views that correspond to traditional design documents such as plans, sections, elevations, schedules etc. As the documents are derived from the same central database, they are all coordinated and accurate – any design changes made in the central model will be automatically reflected in the resultant drawings, ensuring a complete and consistent set of documentation (Graphisoft 2003).

- nD knowledge base: a platform that provides information analysis services for the design knowledge related to the various design perspective constraints of the nD modelling (i.e. accessibility requirements, crime deterrent measures, sustainability requirements etc).
- Decision support: multi-criteria decision analysis (MCDA) techniques have been adopted for the combined assessment of qualitative criteria⁸ and quantitative criteria (e.g. expressed in geometric dimensions, monetary units etc). Analytic Hierarchy Process (AHP) is used to assess both qualitative criteria and quantitative criteria.

The present nD CAD research as demonstrated above concentrates on addressing clients' and users' needs in regards to the building regulations in the UK. This paper suggests it is important to consider lifelong property and owner characteristics that would have significant impact on the property value. It demonstrates below a method that defines of the implementation of these characteristics in future nD CAD system.

4.2. THE PROPOSED FRAMEWORK OF ND CAD SYSTEM

This section discusses how to incorporate the user/ property characteristics into nD CAD system. The researcher suggests translating the user characteristics into building attributes. This would include translation of information about the user, his rights and lifestyle into building attributes. Thus, the impact of these attributes is calculated on the building value as defined in subsection 2.2. Eventually the property attributes and its' impacts would be programmed in the nD CAD system.

To model the property attributes as an integral part of nD CAD system, it is suggested to use IFC classes⁹ standard, in which the building can be defined as spaces that have boundaries and within the boundaries, opening's elements would exist. Each of the building elements has its own attributes. Attributes of each space can be defined by two aspects: the attributes of it's boundaries and the space's own attributes.

Each space or element attribute can be measured on a scale from 1 to 10. Working patterns have become much more flexible over the last two decades. Many people now work from home on a laptop computer, connected to their colleagues via e-mail, video conferencing, web site and fax. There is a need to build flexibility into the structure of buildings so that they can continue to be useful as circumstances alter. Therefore, building elements should be flexible and easily adapted according to the change in

⁸ criteria from the Building Regulations and British Standard documents that cannot be directly measured against in their present form

⁹ See for instance IFC expressed in Express diagram in: [http://www.iai-international.org/Model/IFC\(ifcXML\)Specs.html](http://www.iai-international.org/Model/IFC(ifcXML)Specs.html)

the user lifestyle or change in occupancy pattern. The adaptability of a space can be extremely high (i.e. 10) or low (i.e. 1). The space may have an extremely high (i.e. 10) or low capability (i.e. 1) to accommodate different types of activities. The ease and frequency of maintenance are attributes that can be assigned to a space or an element. Energy rating of spaces and building elements can be calculated and assessed as well. Thus, the impact of these spaces and elements –in regards to the attribute of each one- on the property value can be calculated. The impact of the property location, age and area would be added to the impact of spaces and elements thus the total impact would be calculated.

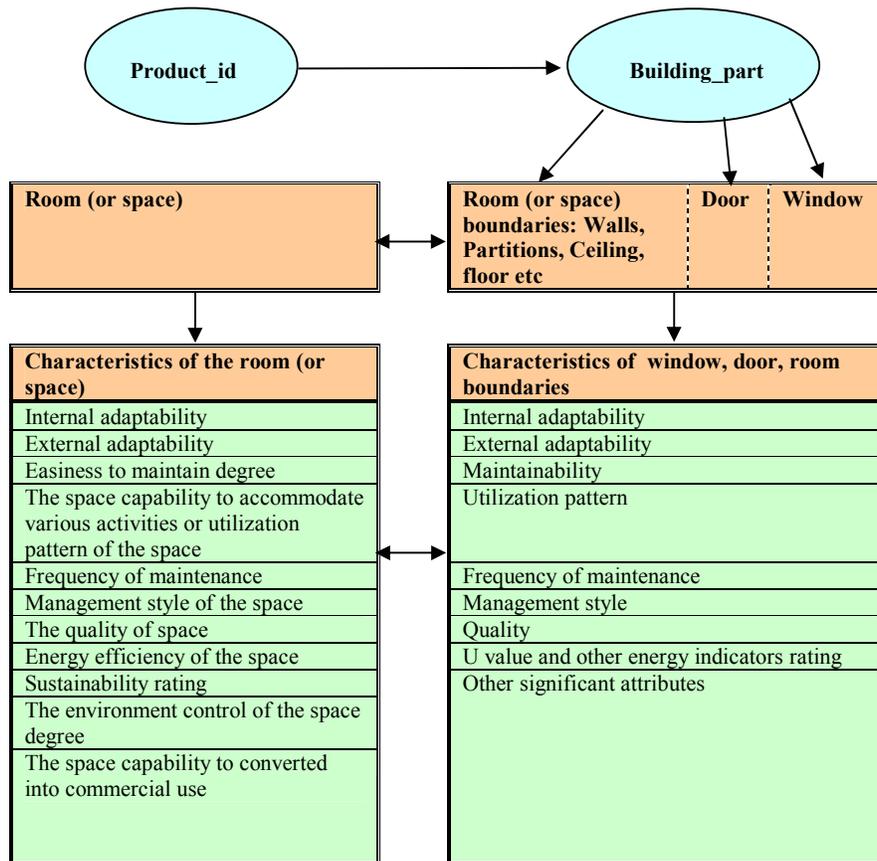


Figure 2, User and property characteristics impact on value for building elements that are structured according to IFC classes (inspired and simplified from EXPRESS diagram)

5. Conclusion and Future research

The paper demonstrated how significant user and property characteristics should be considered and implemented in the future nD CAD system. nCAD system would be used to produce a number of design scenarios in the early stage of design which can be discussed with project team members including the owner, client and stakeholders.

Embedding the user/ property characteristics into the building elements would help the architect to study the impact of the building owner/ property characteristics on the property value. It would also help the client and investor to get proper knowledge about the lifelong cost of the building that is designed in regards to the certain user/ property characteristics and compare between various design scenarios. The system also would help the user/ owner to evaluate the impact of possible practices and changes to the property on the property's lifelong value.

This would assist architects to address lifelong needs of the home owner's/ user's and help the stakeholders, banks and investors to find out how the investment is affected by property parameters. The implementation of user characteristics in nD CAD system would prevent some of the harmful consequences to take place during the building life including the possible unnecessary costs that may incur. The system would help the home owner/ user to decide which design scenario is suitable for him/her and would save future costs. This would make him more satisfied about the end product. The researcher would like to highlight the limitation of the case study and suggests that wider investigation which includes investors, banks, private sector, joint-stock companies and end owner/ user is required to find out the significant lifelong characteristics that affect the lifelong value of affordable property in KSA and would be implemented in nCAD system.

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