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Evaluation of factors for Post occupancy Satisfaction analysis of a Residential Building – A review

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Abstract— In India, Construction has become increasingly a major part of development. In this Construction, residential construction plays a major part of construction. Residential project's success is directly depend upon the customer satisfaction level, but sometimes these standard & specifications do not confirm to the changing needs and expectations of users. This ultimately results in dissatisfaction of customer. This study provides an overview of post occupancy evaluation of residential buildings. It was based on the notion that user's satisfaction with dwelling units is a measure if the performance of residential building in meeting their needs and expectations.

Keywords— *Post Occupancy Evaluation; residential building; defects; building services*

1. Introduction

Quality management in the residential sector has received considerable attention as a result of defects. The impact of defects is tremendous to the occupants, whether they are owners or tenants of the house. The factors behind housing defects always lead to occupant's dissatisfaction while satisfaction is main key towards the customer's loyalty behavior. Everyone believes that satisfaction has a relation with a good housing condition. The indicator of good housing condition is in terms of defects' occurrences. More defects occurring in occupant's houses will lead to dissatisfaction.Thus this project aims to be a tool for the study of post occupancy survey for residential projects. The result of this post occupancy evaluation will serve as a very powerful tool. That can be used for continuous improvement for housing projects.

1.1 Objectives

- Comprehensive study of literature in order to identify current critical issues related to post occupancy services.
- To establish questionnaires through literature study in the domain and opinions of field experts.

2. Literature Survey

A literature search was conducted to determine the current critical issues related to post hand over of Residential Building & common defects in construction of residential buildings.

Post occupancy evaluation is defined as it is a survey or set of data which involves systematic evaluation of opinions about the buildings in use, from the perspective of the people who use them. Study of post occupancy evaluation of residential customer satisfaction is measure of people's attitudes towards certain aspects of their residential environment.

The satisfaction of customer is directly proportional to the number of defects found in construction at occupancy stage. Defect can be defined as the improper work or error in work that may be caused either by material or by workmanship. Sometimes it is also caused by incorrect methodology adopted for execution of the work.

Quality of residential building was also directly related to the number of defects found in that property. Some defects are due to workman ship & design decision. These types of defects are very common type of defect, found in almost all civil engineering projects. This is because of shortage of skilled labour of desired level. The defect can be classified in to different category depends on its severity too. If the severity of defect more than recommended than it can also damage the structural element of building. The defects are not in construction of building but also in services of Building such as lift, fire fighting, plumbing, electric fitting etc. Someone has stated that building without services running is like human without running blood in veins. So services play very vital role in case of Building. Above discussed all the points are studied by various experts & explain them as follows According to Adesoji (2012 – p. 237), the post occupancy evaluation is defined as it is "a generic term for a variety of general programs and procedures as well as specific techniques for the evaluation of existing building and facilities". It involves systematic evaluation of opinions about the buildings in use, from the perspective of the people who use them. It assures how buildings meet users' needs, and

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identifies ways to improve building design, performance and fitness for use.

According to Vischer (2002), Post-occupancy evaluation (POE) originates from "an interest in learning how a building performs once it is built, including if and how well it has met expectations and how satisfied building users are with the environment that has been created" created .

According to Zimring (2010), these early studies gathered information about the responses of occupants to buildings through questionnaires, interviews, site visits and observation, sometimes linked to physical assessment of the building, with the objective of understanding the performance of design elements, identifying best practice approaches and also what should not be repeated in future (Federal Facilities Council, 2002).

According to Steveson (2009), this mixed-methods approach and investigative ethos principally focused on user experience remains central to most contemporary approaches to POE. Recent developments are characterised by two trends: the creation of standardised POE methodologies for specific building types (e.g. offices, healthcare and educational facilities) and the extension of the scope of POE activities to incorporate evaluation and feedback at repeated intervals during the building delivery lifecycle.

According to Zimring (2010), as the discipline has expanded and become more specialised, so too have the terms used to describe it, for example facility performance evaluation, environmental design evaluation, environmental audits, building-in-use assessment, building evaluation, facility assessment, and building performance evaluation. In recognition of this diversity of objectives and application

Vischer (2002) offers a loose definition of POE as "any and all activities that originate out of an interest in learning how a building performs once it is built, including if and how well it has met expectations and how satisfied building users are with the environment that has been created". Now we have studied that what is post occupancy evaluation.

Now we will move towards the relation between the customer satisfaction & post occupancy evaluation.

2.1 Post occupancy customer satisfaction

According to Pablo, (2014 – p.418) customer satisfaction is the feeling of pleasure or disappointment resulting from comparing the perceived performance of a product with the customer's expectations. Five types of attributes that a product or service may possess and which generate various feelings of satisfaction or dissatisfaction in customers:

According to Eziyi (2013 – p.178), satisfaction levels were generally higher with privacy and sizes of living and sleeping areas than the availability of water and electricity in the building. The type, location and aesthetic appearance as well as size of main activity areas were most predominant factors that determined satisfaction and indeed the performance of building in meeting user's needs and expectations.

According to Eziyi (2013– p.179), satisfaction is subjective evaluation of performance of products or services in meeting the needs and expectations of users or customers. It compares the benefits or values user or customers derive to that expected when a product or service is consumed.

According to Adesolji (2012 – p.237), Residential satisfaction is a reflection of "the degree to which feel is helping them to achieve their goals". It refers to the individual evaluation of the condition of their current residential environment, subject to their needs, expectations and achievements. Theories on residential satisfaction are based on the notion that residential satisfaction is measure of the difference between occupants' actual and desired housing and neighborhood situations whose judgments are based on their needs and aspirations. Contrariwise, they are likely to feel dissatisfied if their housing and neighborhoods do not meet their residential needs and aspirations. (Pg. 237 – Pt. 2.1)

According to siti nur fazillah (2012 – p.77), satisfaction is the feeling of contentment that buyers receive when houses that they purchase fulfill their needs or desire. While dissatisfaction is the feeling emerged when the performance is low than the standard. He also added that higher level of defect is assumed to be suggestive of low quality houses and will cause dissatisfaction to the occupants. Aforementioned statement shows the relation between defects & satisfaction.

Till now we have gone through the post occupancy evaluation of residential building & customer satisfaction review. Now this customer satisfaction is directly related to no. of defects found in residential building, therefore we are moving towards the type of defects, number of defects found in residential buildings & how it is related with customer satisfaction.

2.2 Defects

According to Anthony (2009 – p.12) the definition of failure & defect are as follows. "A failure is a departure from good practice, which may or may not be corrected before the building is handed over. A defect, on the other hand, is a shortfall in performance which manifests itself once the building is operational."The *severity* of a defect has also been given ubiquitous attention in the literature, as definitions that have been proposed have been thwarted with ambiguity and uncertainty have suggested that defects can be classified as being *minor* or *major*. Minor defects are those that arise from poor workmanship or defective materials used in the erection or construction of the building but do not render the building unsafe, uninhabitable, or unusable for the purposes for which the

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building was designed or intended. A major defect, on the other hand, is defined as one which "renders the building unsafe, uninhabitable, or unusable for the purposes for which the building was designed or intended."

According to Marcel, defects have become an "acceptable part of the building process"

ISO 9000:2005 (ISO 2005) defines defect, too, as "the non-fulfilment of a requirement related to an intended or specified use." On the other hand, Georgiou et al. (1999) suggest that the simplest and most comprehensive definition is that provided by the Oxford English Dictionary, which defines a defect as "a shortcoming or falling short in the performance of a building element." This definition has been legally validated by the case of Schuller AG v. Wickman Machine Tools Sales Ltd. (Dorter and Sharkey 1990). The CIB Working Commission W86 (1993) also supports the above by defining a defect as "a situation where one or more elements do not perform its/their intended function(s)." Watt (1999) improves the definition and considers that "defect is the term used to define a failing or shortcoming in the function, performance, statutory or user requirements of a building, and might manifest itself within the structure, fabric, services or other facilities of the affected building."

According to siti nur fazillah,(2012 – p.77) defect can be said as one of the imperfection in newly built house and will lead to the house buyer's dissatisfaction.

In the building and construction literature, words like "error," "fault," "failure," "defect," "rework," "quality deviation," "non conformance," "quality failures," and "snagging" have been used interchangeably to describe imperfections in constructed buildings (Josephson et al. 2002; Georgiou et al. 1999; Love 2002; Mills et al. 2009; Sommerville and McCosh 2006). These words are emotive terms and mean various things to different people, but they always suggest that the client involved has had an unsatisfactory experience (Ilozor 2004). The lack of differentiation between the terms used can lead to inaccurate and incomplete measurements, cost determination, and possibly inappropriate strategies for reducing their occurrence (Mills et al. 2009).

It is common to use "rework" as a synonym for "defect." However, rework is defined as "the unnecessary effort of

redoing an activity or process that was incorrectly implemented the first time" (Love and Edwards 2005; Love 2002). Therefore, when a defect occurs and is rectified then it is referred to as a rework.

Other terms are used to discriminate the phase in which defects are detected. For example, "latent defect" is a term used to describe imperfections in constructed buildings, or to refer to defects that appear during the occupancy stage (Chong and Low 2006). During the post-handover stage, which usually lasts 12 months after the handover period, the term "snag" is also used in the United Kingdom construction industry but not extensively in the literature. Thus, snags are those defects that are "visible" to the contractor and end user once the home is deemed ready for occupation (Sommerville and McCosh 2006).

In above discussion, we have gone through various definitions of defect. After studying the definitions, now we can move towards the types of defects in residential buildings.

2.3 Defects in residential Buildings

After studying those defects produced during post handover stage Marcel (2012) concluded that, most common defects were incomplete tile grouting & incorrect fixtures & fittings in toilet. In addition, failure to apply second coats of paint to walls was deemed a problematic issue. Typical surface/appearance defects were found to include floor or wall unevenness, stains, mess, small cracks, and marks mainly caused by lack of protection.

According to ahmad sufian (2013), the common building defects are waterproofing issues, cracks, soil settlements, wall finishes problem, staining, lack of knowledge and expertise on maintenance aspects. He also explains above mentioned problems by explaining the issues & showing the photos of defects.

Ahmad suffian (2013 – p.101) also explains that, the performance of waterproofing system depend upon on many factors i.e. quality of material, skill of workers, application methods, substrates condition, weather, maintenance etc. According to ahmad suffian (2013 – p.104), a typical crack of building in Malaysia is of non structural type i.e. shrinkage cracks, joint cracks etc. surface cracks are commonly found on floor screed and normally caused by improper curing process. Joint cracks are commonly seen at the joint of different structural elements such as column / brick wall and beam/brick wall.

According to Watt (1999)'s thorough examination of the causes of defects found that biological, meteorological, geochemical & other natural hazards, human intervention, pollution, mismanagement, inappropriate use and poor maintenance & remedial work were responsible for most building defects. This seemed to suggest that inappropriate materials applied to buildings, poor decisions and poor rectification work processes caused these defects.

According to Wai-Kiong chong (2006), proposals for defect repair focused on the impact of the weather, environmental conditions, soil, poor design, chemical attack, structural movement (due to poor structural design), installation method, workmanship, maintenance and site working conditions.

Wei pan (2013 - p.1) says that, kitchen & bathrooms remained the two most defective areas. Larger houses were found to be more significantly more defective than smaller flats.

Nuria forcada (2012) suggested that quality was directly related to the number of defects found in a property. Auchterlounie (2009) reported that the number of defects is a key indicator of the quality of homes that has been used

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in the house building industry. In addition to its use in practice, the number of defects measure has been widely adopted in research.

According to Wei pan (2013 – p.2), Defects may be associated with any element or function of the building. For example, nine types of residential house defects in Victoria, Australia—namely, rising damp, framing, illegal building, stumps, timber rot, cracking, electrical, roofing, and water supply.

Wei pan (2013 – p.2) identified that typical defects in residential buildings included: cracks in walls, especially at natural lines of structural weakness (e.g., windows, door junctions with extensions and bays); bulging/bowing of walls; rising dampness; uneven ground-floor slabs; movement in upper floors; damp penetration of roof; cracking to render; loose/hollow render; condensation; faulty heating, plumbing and electrics; and blockages/leaks to drainage.

Wei pan's (2013 - p.2) list is not exhaustive but provides a useful outline of the usually encountered defects. He summarized the many building defects into several common types: structural defects resulting in cracks or collapse; defective or faulty electrical wiring and/or lighting; defective or faulty plumbing; inadequate or faulty drainage systems; inadequate or faulty ventilation, cooling or heating systems; inadequate insulation or soundproofing; and inadequate fire protection/suppression systems.

Some other studies in the past have focused on specific elements or functions of the building. For example, Chew (2005) identified 14 major defect categories in wet areas of buildings—namely, tile debonding, mastic failures, staining of tiles, staining of ceiling boards, staining of vanity tops, staining at fittings, water leakages through cracks, water leakage through pipe penetration, water leakages through joints, corrosion of exposed drainage pipes, paint peeling, water ponding, spalling of concrete, unevenness of tile surface, and poor pointing. Chew (2005) recorded leaks as the most common type of defect in the wet areas, accounting for 53% of all the defects studied. Lourenco (2006) reported eight groups of damage in the envelope of the building stock:

i. collapsed structures,
ii. bulging walls,
iii. stains on walls at soil level,
iv. detachment of rendering and painting,
v. cracks,
vi. mold, fungus, and vegetation,
vii. roof deterioration, and
viii. Timber deterioration in opening frames or balconies.

A further example is Johnsson and Meiling's (2009) study of off-site prefabricated timber modules in Sweden. The recorded defects of the modules included holes and mess on the walls caused by craftsmen, missing linings around doors and windows, and doors in need of adjustment owing to movements in the structure; 33% of all recorded defects were related to walls, and 52% were related to walls or openings.

The many previous studies of building defects have revealed a wide range of factors that lead to and/or influence building defects. Such factors fall into two general groups: (1) causes of defects that cover the reasons and sources leading to defective work— e.g., inappropriate design, poor workmanship, insufficient quality control, and impaired materials, and (2) influencing factors on the profile of defects that cover the building parameters and design specifications and may not necessarily and directly lead to defective work—e.g., build method, performance standard, size of dwelling, and dwelling type. This paper is focused on the second group of factors in order to address the aim of examining the profile of building defects.

Quazweeni and daoud's (1991) research on concrete defects in a 20 year old office building concluded that chemical attack and poor workmanship caused defectd and that laboratory testing yielded inaccurate results and thus could not be relied upon for predicting defects. They stated that chemistry could be used to predict concrete defects. Their research also suggested that many building defects are latent in nature and do not appear early in the construction stage.

In above discussion, we have seen that most of the defects are due to defective material & techniques. Now we will study the defects due to workmanship & design decision.

2.4 Defects due to workmanship & design decision

According to Atkinson, managerial errors accounted for more than 82% of all building defects and that these errors have hidden or latent characteristics, suggesting that such errors were not visible at the construction stage.

Anand examined the resistance of newly developed masonry work to dampness and leakage and found that better design helped to prevent defects because it could eliminate workmanship defects.

According to ahmad sufian (2013 – p.104), workmanship issues are always associated with small contractors as they are not well trained to be in construction industries. In Malaysia small size construction companies are categorized as class F and allowed to carry out works worth below MYR 200,000. In many cases their quality of works is low due to lacks of experiences and improper guidance from the relevant parties. He also added that, workmanship issue does not arise among established contractor/suppliers as they have strong financial record and expertise in carrying the works. Malaysian government through various entities has been making efforts to improve knowledge and skill of those small contractors by conducting field training, seminar and short courses. Atkinson (2002) constructed a conceptual model of human errors operating in complex project systems that may lead

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to defects, which include primary factors mainly related to manual operatives; managerial factors related to checking work; division of responsibilities; control of change; control of concurrent working and communications; and global factors influencing the project environment both within an organization and wider economic, time, political, and societal pressures. Atkinson (2002) reported that managerial factors predominated in the occurrence of defects, followed by global factors and, lastly, primary factors.

Nuria forcada (2010) explains that, in Spain, for example, 94% of construction firms have fewer than 20 employees (Asociación de empresas constructoras de ámbito nacional 2009). These problems, combined with the fact that it is the main contractor who is ultimately responsible for delivering quality at a competitive cost, mean that some defects are not solved in the construction and handover stages. As a result, these defects remain in the post-handover period, when the building is supposed to be completely finished. Compounding the matter, end clients do not become involved in the construction process until it is nearly over. In fact, clients play a negligible role in defining both the functional requirements and the quality standards of new houses.

Chew (2005) concluded that the occurrence of the studied defects in wet areas of building are broadly attributed to their sources of deficient construction (43%), material (37%), design (11%), and maintenance practices (9%).

According to Marcel, Usually data pertaining to defects is difficult to obtain and even when accessed the information is not standardized. To analyze the data, a standardization process is required. It is necessary for the data to be organized and possibly re-formed and expanded where necessary to enable useful data for research purposes to be extracted.

We have gone through the various types of defects which were not only caused by material & techniques but also by workmanship & design decision. Now we will continue with the level of severity of defect.

2.5 Level of severity defects

According to Wei pan (2013), Parameters exist in the literature measuring the criticality or severity of defects—e.g., failure frequency and severity and likelihood and impacts of risk.

Assaf (1996) assessed and ranked the relative severity effect of building defects using a severity index with four groups—namely, “most severe” (with a rating from 75 to 100), “moderately severe” (50–75), “slightly severe” (25–50), and “non-severe” (0–25) defects. The ranking, however, was based on the surveyed views of 30 maintenance contractors and 20 owners in Saudi Arabia. Therefore, their study—although it attempted to hypothetically quantify the severity of defects—failed to address the different interpretations of the respondents as well as the implications of the defects in real cases.

Das and Chew (2011) measured the criticality of defects with more tangible indicators through their frequency and severity of impact; the frequency of building defects was defined using a five-point Likert scale as follows: “very rare (once per 10 years or rarer),” “rare (once per 5 years),” “occasional (once per year),” “frequent (once per 3 months),” or “very frequent (once per month or more frequent).”

Till now we have seen the construction defects & some services defects. Now we will get in deep for defects in services of Buildings

2.6 Defects in building services

According to Marcin (2013), building management is performed during the phase which follows the building phase of a building’s life cycle – the operation phase. This phase involves several management activities among which the most important in technical maintenance of a building. The abandonment of these activities may limit the function ability of building and in extreme case; shorten a facility’s life cycle.

According to Natalija (2013), facility management service quality is expressed by client satisfaction indicators. According to marcin (2013), facility’s lifecycle is broader term as it covers not only the investment process, but also stages connected with the use of the facilty and its possible “death” and recycling. Technical maintenance activities, including repairs and renovations are in fact a part of the stage connected with building exploration.

According to natalija (2013), real estate owners often insist on saving resources at the expense of long term sustainable life cycle of a building. Nevertheless, due to its hardly measurable nature, facilities management is often characterized by a large number of real estate owners as evitable evil.

According to K. Alexender (1996), broadened need the concept of facilities management quality and described it as balancing the surrounding environment and assisting organisations meet their strategic needs. Quality determines the usefulness of a service to the user as well as commercial success to the service provider. Due to low quality, organisations do not only experience moral damage (dissatisfied customers & staff) but also material loss.

According to Natalija (2013), over a third of costs in service organisations are allocated to error corrections. Quality assurance has a cost; therefore, it is worthwhile to increase quality only up to the required level rather than aiming at perfection.

According to ISO 9001:2008 quality management systems, facility management services can be divided in 4 levels: preventive, correctional, improving & top quality. Services of the first level are aimed at ensuring the stable

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condition of a building and they do not depend on owners' desires or their perceived quality.

According to nor'Aini yusof, it is common for any residential buildings to have to confront with problems of building decay and deterioration, which are inevitable through the effects of usage, wear & tear. In order to extend the life of the building, it is vital to have proper maintenance so that all negative effects can be reduced or eliminated.

According to Watt (1999), maintenance of facility is complicated operation which most residents as lypersons find difficult to perhaps understand, or to address them. It has been argued that the maintenance process should be based on an understanding of the building construction and followed by actions that conserve and boost the value of a building, which warrant a higher understanding of maintenance.

3. Conclusion

This study sets out on a post occupancy evaluation of resident's satisfaction with their dwellings residential environment.

By studying the post evaluation survey of building we come across how well buildings match users' needs, his expectations and how satisfied building users are with the environment that has been created for his residents.

Defects can be classified as being minor or major. Minor defects are those that arise from poor workmanship or defective materials used in the erection or construction of the building but do not render the building unsafe, uninhabitable, or unusable for the purposes for which the building was designed or intended. A major defect, on the other hand, is defined as one which "renders the building unsafe, uninhabitable, or unusable for the purposes for which the building was designed or intended.

Kitchen & bathrooms are remained the two most defective areas measured, both in number & in severity of the defects.

The most common defects are tile debonding, mastic failures, staining if tiles, staining of ceiling boards, staining of vanity tops, staining at fitting, water leakages through cracks, water leakages through pipe penetration, water leakages through joints, corrosion of exposed drainage pipes, paint peeling, water ponding, spalling of concrete, unevenness of tile surface & poor pointing.

Defects are summarized into several common types structural defects resulting in cracks or collapse, defective or faulty electrical wiring or lighting, defective or faulty plumbing, inadequate or faulty drainage system, inadequate or faulty ventilation, cooling or heating systems, inadequate insulation or soundproofing & inadequate fire protection/suppression system.

By studying above literature it is also concluded that quality was directly related to the number of defects found in a property. Also number of defects is a key indicator of the quality of homes that has been used in house building industry.

Literature review showed that no study quantifies the cost of defects in the building industry, even though construction industry still accounts for considerable percentage of gross domestic product or Indian budget.

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