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TITLE: THE DEVELOPMENT OF BUILDING EVALUATION METHODOLOGIES: FORGOTTEN IDEAS AND THE STATE OF THE ART.

AUTHOR NAME: PETROS TSITNIDIS

The Leeds School of Architecture, Leeds Beckett University, Room B502, Broadcasting Place, Woodhouse Lane, Leeds, LS2 9EN, United Kingdom

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ABSTRACT

For a long time, sustainable design of buildings has focused on reducing energy consumption. This has taken architectural design away from understanding the wider variety of factors that affect the building during its lifetime.

This paper summarizes the findings of the most influential Post-Occupancy Evaluation methods that have been published during the past 60 years. It aims to monitor the changes that have occurred to the methodology, and create an understanding of the different issues they have explored. Current building evaluation methods are not widely applied due to barriers that originate to reasons that are no longer applicable. UK building legislation recommends Post-Occupancy Evaluations in buildings, but seems unable to demand it. Contemporary evaluation methods offer benefits, but fail to create a framework that would follow the building throughout its life cycle, as they are investigating a limited amount of factors that affect its performance. There is a need for a more generalised approach to building design that would take into consideration factors like occupant opinion, architectural design together with energy consumption. The Soft Landings framework offers a simple and easy to use method, but is designed for non-domestic buildings.

The paper proposes the research of a variation to the Soft Landings framework, appropriate for domestic buildings, which constitute a large fraction of the built environment. This method would aim include the users in the design process, educate and inspire them about the efficient use of their home, throughout its lifetime.

Introduction

For more than half a century, there has been a growing need to obtain feedback from buildings. Since the early examples of post-occupancy research in buildings (Manning, P. N. et al., 1965; Ryn, Van der et al., 1967; Markus et al., 1972), designers and researchers have constantly aimed to understand the factors that affect the building during its lifetime. Different occupants, variation of needs, changes of use, maintenance, and technological advancements are among the issues that have been spotted to mainly affect the buildings. Inclusive tables of these factors have been published for a variety of building types that were examined during the 1970s (Friedmann et al., 1978).

Understanding the importance of the users and their influence on each building should be an integral part of the design process; a process that should not stop on the sign-off of the building to the client, but continue throughout its life time. Especially in the domestic sector, building performance depends on use. As the user and their needs evolve through time (number of occupants, user occupation, climate change, etc.), it is imperative that the building design and services should evolve accordingly. Depending on the retrofit requirements, any changes, from minor design issues to major retrofit, need to be carried out by experts in each respective field, according to trade regulations.

This paper aims to present the results of the literature review that the author currently undertakes in order to create a firm theoretical substrate for his Ph.D. research that is currently under way. This review would substantiate the research questions and assist the decision for the work that needs to be conducted for the purposes of the Ph.D.

Building evaluation tools and methodologies throughout history

The value of obtaining feedback and evaluating a building's design has been presented very clearly throughout literature and many professions constantly use feedback methods to push their products forward. Bartholomew describes the process of learning through observation and questioning of the environment even from our infancy. The collection of information and data is crucially important and today's technology assists in the collection of data at a very large scale. He adapts this process to the construction sector and collects expertise and opinions from a number of important players that cover a large spectrum of specialization. He describes the methods of knowledge organization these companies utilize in order to organise lessons learned and improve cooperation for future projects (Bartholomew, 2008). Additionally, Wheeler considers the existence of feedback tools essential for sustainable design (Wheeler, 2013). Even though large design and construction companies make good use of the abilities that technology offers, on the "Edge" building in Amsterdam for example (BREEAM, 2016), building evaluation methods are not used widely enough in order to succeed an important effect to the actual built environment.

Research in building evaluation methods dates back to the early 1960s. It was at that time that the Royal Institute of British Architects (RIBA) introduced "Stage M: feedback" on the final part of the "Plan of work for Design Team Operation" guideline (Royal Institute of British Architects, 1963). Since then, research on the subject has focused on the procedures needed. Different methods were designed to fit different building types and different purposes at the time.

In 1965 a very exhaustive study was conducted at the Cooperative Insurance Society building in Manchester, which was completed in 1962. After an exhaustive analysis of the building, the researchers approached the staff, in order to understand those features in the building that are influential in determining a person's subjective reactions to his workplace. The staff provided their views on the building through questionnaires and interviews. The conclusions of this research focused on architectural and interior design and building quality (Manning, P. N. et al., 1965).

A study of high-rise dorms in Berkeley, published in 1967, introduced the research in the behaviour of the dorm residents as a deciding factor for the use of the building. The researchers used questionnaires, activity logs, diaries and sketches drawn by the respondents in order to understand the main factors that affect the design of the dorms during their use. It may be one of the first times that a similar research included psychological factors in its findings. The institutionalisation feelings the students experienced created a negative approach to the building. The inability of the students to intervene with the room design created additional frustration and feelings of impersonality. The students refrained from using the common rooms and preferred to use the corridors for socializing. The findings of this research resulted to comments on the university housing policy and the academic needs of the students (Ryn, Van der et al., 1967).

In 1972, the Building Performance Research Unit, based in the University of Strathclyde, focused its research on school buildings, a choice made mainly on the convenience of the field. They published the methodological analysis of two cases and gathered data from 28 UK schools. The main focus was the connection between the building and its users. As a result, any construction or design fault would have "real, human consequences". Data was collected by 510 teachers by the use of questionnaires and the issues addressed included examination of building services, structure and condition, occupancy schedules and environmental factors (Markus et al., 1972).

Another subject that was looked into during the 1970s was the safety of domestic areas. Research that had taken place in the early 1970s examined 100 housing projects in terms of links of design with crime (Preiser et al., 1989). Findings of this research included issues on the design, the public or private character of public spaces, the size and number of apartments in buildings, their management and condition and the socioeconomic characteristics of the residents (Newman, 1996).

One project that concerned a domestic building was included among other building types in a 1978 research publication that presented the general characteristics of environmental design evaluation research. Rather than searching the cause, the research aimed to understand the influences that led to the condition of a space or building. Again in this case, the 220-unit apartment complex was evaluated in an effort to understand how the design decisions were made and how the residents used and felt in their homes. This study again found that sociopsychological and design factors were the main influencers for occupant satisfaction (Friedmann et al., 1978).

Another approach towards the understanding of the factors that affect the building during its lifetime was presented in 1984, which examined use by-products and adaptations, displays of the self of the user, public messages and voluntary and involuntary behavioural patterns that emerge in different spacial formations. This research seems to be the first to propose an interdisciplinary approach to building evaluation, as it includes a psychological aspect in behavioural analysis (Zeisel, 1984).

The 1980s marked a significant change in the approach taken to the evaluation of buildings. The introduction of the sustainable development agenda and the energy crisis that took place during the decade provided additional momentum to buildings research.

Research into what came to be the Building Use Studies (BUS) methodology has its roots around 1985. Early trials like the Office Environment Survey attempted to create an understanding on how extended was the Sick Building Syndrome (SBS) phenomenon at the time. More than 4.000 workers in 46 buildings responded to a questionnaire survey on their sense of the working environment and different symptoms that were common with the SBS (Wilson, 1987). Other questions referred to the following subjects: environmental comfort, satisfaction with amenities, time spent in building, time spent at task, productivity and background data. By 1995, the survey had taken place at 120 buildings and the researchers had gathered a database of more than 10.000 respondents (Leaman, A., 1995).

The facilities management focus of the practice of building evaluations that begun with the BUS methodology and continued with research published in the United States (Preiser et al., 1989), boosted research in the sector but took the focus away from domestic buildings. The BUS methodology evolved and the research group started working on the Post-occupancy Review Of Buildings and their Engineering (PROBE) initiative. It incorporated a series of stages that included different types of questionnaires, site visits, the BUS occupant survey, energy analyses and an air leakage pressure test (Cohen et al., 2001).

The PROBE studies initiated a strong momentum in the field. The Energy Analysis Reporting Methodology (EARM) that was introduced by these studies was adopted by the Chartered Institution of Building Services Engineers (CIBSE) to become the first edition of the Technical Memorandum 22 (TM22: 1999). TM-22 was a three-stage process and during each stage it looked into different depths of the building. Initially, it broadly analysed simple annual consumption indices by fuel. The intermediate level, reserved for more complex buildings, considered occupancy, weather and unusual energy uses. The advanced level of study was intended for detailed assessment of the building. It included energy load pattern analysis and occupancy schedules. The 2006 revision focused even more on the energy performance of buildings in an effort to implement the relevant EU Directive (CIBSE, 2006).

The TM-22 focus on the energy consumption of the building as a method of assessment of its performance though, diverted from the focus on architectural design, construction quality and endurance, issues that the earlier methods incorporated. The occupants had now disappeared from the equation and had become a behavioural research subject in order to be included in simulation software. The research now had focused on finding a way to predict the use of the building elements that mattered to the results of the simulation software.

Research now sources data from databases concerning the use of windows, blinds, lights, heaters and fans in 25 buildings around the world. It then tries to analyse them in comparison to outside temperature data in order to feed the results to thermal simulation models for buildings (Nicol, J. F., 2001). In the same manner, mathematical models are utilised in an attempt to find the probability of the ways building occupants might respond to thermal discomfort (Nicol, J. F. & Humphreys, 2004). Other research uses real time energy load demands and temperature readings combined with existing behavioural models in order to predict thermal comfort in office spaces (Hoes et al., 2009). All these and many other studies (e.g: (Seryak & Kissock, 2003; Garg & Bansal, 2000; Bourgeois, D. J., 2005; Clarke, 2001)) that try to predict human behaviour and import it to even more complicated building simulation models emphasise the importance of the human factor but fail to produce a viable and reliable prediction model. As a result, when one research team attempts to list one set of factors, they are forced to ignore other equally or even more important ones due to inability to process all of them and include them in inclusive mathematical models, for example: (Langevin et al., 2015; Masoso & Grobler, 2010; Nicol, F. et al., 2012). Additionally, research is mostly conducted in controlled office, educational and/or cyber/ simulation spaces, while the domestic sector is largely ignored.

The change of focus

The change of focus that happened during the 1980s and has followed the evaluation methodology ever since, has led to the serious problem that the sector faces today: a significantly limited amount of building evaluations taking place. Published research pinpoints the different criteria that designers and occupants use to evaluate a building (Zimmerman & Martin, 2001). Similar differences were also identified by the PROBE team (Cohen et al., 1999). The main barriers that research presents is the lack of economic incentive for the designer, the willingness from the part of the developer to minimise the costs, the inability to allocate the responsibility and repair costs and the limited benefits that arise from the evaluation for each building or part of a building (Zimmerman & Martin, 2001).

The research gap in domestic buildings

This review of the research in the subject shows that priority has been given to non-domestic buildings (Leaman, A. et al., 2010). Reasons for this focus are likely to be ease of access, control and critical mass in costs, population and use of spaces. The case of “The Edge” building in Amsterdam, designed by PLP Architecture is a clear example of the technological possibilities that can be introduced in an office building, using technology available today (BREEAM, 2016). Time will only tell whether this example of integration of technology and architecture will actually work and provide for its promises of sustainability and usability (PLP_Architecture, 2016). The data, though, that will be available by the use of the building is one of the most important challenges that its managers will face. In-use data and the detail that it will entail is likely to make the distinction of the important patterns very difficult. In addition to this, there seems to be a turn to automation while user comfort and understanding of behaviour constitute issues that are not given priority, mainly due to their complexity. Unfortunately, the same problem exists in the housing sector (Leaman, A. et al., 2010).

Going back to the research deficit that concerns the performance of domestic buildings (Leaman, A. et al., 2010), a substantial gap exists in research that needs to be covered in order to complete any steps towards the purposes of sustainable development agenda and the Paris climate agreement of 2016. The need to focus on the domestic sector has already started being addressed in the UK, though. Schemes like Innovate UK's "Retrofit for the Future" and Building Research Establishment's "Home Quality Mark" are efforts that point to the right direction and aim to tackle the issues that affect the larger parts of the built environment. Their practice, though, remains limited, as "Retrofit for the Future" resulted in the retrofit of just over 100 domestic buildings (Technology Strategy Board, 2013) and "Home Quality Mark" is still in research and development stage (BRE, 2015). On the other hand, Energy Performance Certificates (EPC) that are required by law for the construction, purchase or lease of domestic properties have not had important effect on their purpose. Research on the impact of EPCs has shown that energy efficiency plays minimal role in the homebuyers' decision-making process, while their majority do not undertake the proposed retrofitting suggestions (Watts et al., 2011).

Conclusion: Soft Landings and its possibilities

The impact and effectiveness of the PROBE studies evolved to the currently used Soft Landings Framework. Its success resulted to the acceptance of the framework by the UK Government which introduced the Government Soft Landings, an interpretation of the framework aimed at centrally funded projects.

The framework's non-domestic roots have followed the process until today. Even though the official directives and publications for the framework do not explicitly exclude domestic buildings, the whole process is designed for non-domestic application. Taking into consideration the fact that in 2015 alone, planning permissions that concerned dwellings were 14.85% of the total developments in England, as opposed to 0.64% that concerned office buildings (Government, 2015), any efforts to improve the performance of office buildings would have minimal effect to the purposes of any sustainability legislation.

The design stages that the Soft Landings Framework introduces are similar to the RIBA plan of work and constitute a good start for the design of domestic buildings. Even more, the end users of the building could be more accessible, more willing to complete the stages of the process efficiently and even extend the aftercare period beyond the three year period that the framework aims for (Way et al., 2009).

One of the most usual complaints in the sustainable design and construction sector concerns the unwillingness of the occupants, whatever the building use, to comply or even understand the scenarios and strategies the designers have implemented to the building. There is a need for a simple method that could inspire and convince the domestic building users to understand the benefit of these strategies. The Soft Landings Framework is a simple, easy to use guideline that has been adopted by the UK Government. It aims to engage as many stakeholders as possible in the design process. A new Soft Landings version, appropriate for domestic buildings, is required. It needs to be informed by the factors that building evaluation methodology has examined traditionally in order to cover the whole complexity of the building's lifetime. More widespread use of such a framework would significantly benefit the

market and inspire a cultural change towards the more efficient use of our homes and eventually, more sustainable lifestyles.

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