The impact of design decisions on post occupancy processes in school buildings

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Abstract

Purpose: This paper reviews the impact of design and specification decisions for major works during post-occupancy processes; the routine maintenance and management of school premises. It also explores the relationship between the main stakeholders and how this impacts decision making and the post occupancy operation of the school buildings.

Design/methodology/approach: In addition to literature review, qualitative data was also obtained through focus group; a steering group. The steering group consisted of stakeholders tasked with delivering and managing school premises in the Sussex County.

Finding: A contribution to understanding the impact of design decisions on post occupancy processes in schools. A basic model was also presented as a guide for requirements and decision mapping in post-occupancy design decision processes in schools.

Research limitations/implications: The study was conducted with the participation of representative sample of stakeholders. There may be the need to further investigate the issues in a localised context before detailed solutions are proposed.

Practical implications: The paper reports findings based on the needs, requirements, and preferences of the stakeholders as well as the opportunities and constraints to improving the quality of design processes which in turn will improve post occupancy processes.

Originality/value: The paper highlights the complexity of design decision making in schools, presents the viewpoint of stakeholders, and proposes basic model to ensure performance for post occupancy processes to inform the next stage of the research.

Keywords: Building performance, Design decision making, information and knowledge flow, post occupancy processes, school buildings, user studies.

Background

Post-occupancy building practises are interventions to obsolescence, dilapidation, deterioration, deficiencies in performance and sustainability of buildings including operational and management activities. For this reason, information about a building (functionality and use) should evolve as the building itself evolves. This explains the growing interest in the continuous data collection and documentation of buildings. However, data collection is only a small fraction of what is needed to usefully assess building performance, and for making informed decisions about building works.

Post occupancy building work is crucial for maintaining the serviceability of school assets. Central governments in the UK spend a significant amount of time and a remarkable portion of their budget
on education. Available funding for capital investment in school buildings has had an increasing profile, from £683 million in 1996-97, to £3.8 billion in 2003-04, and £8.2 billion in 2011.

The former Department for Education and Skills DfES launched a new Building Schools for the Future (BSF) investment programme in 2005-2006, to help boost education in deprived and low performing areas in England. BSF was primarily aimed at secondary education but was soon accompanied by a parallel programme, the Primary Capital Programme (PCP), for primary schools in March 2006. The main aim of the BSF was to provide school buildings for the 21st century at the scale that has not been seen since Victorian times. It was designed to rebuild or refurbish all secondary schools in England over a 15 year period at a cost of £45 billion, with local authorities participating in a series of 15 ‘waves’. Even at its peak, the programme was believed to be immensely ambitious (House of Commons 2007).

As a result, an overhaul of England’s school building programme was announced in July 2010, affecting all school building programmes especially the BSF (DfE 2011a). Nevertheless, the Department for Education (DfE), DfES’s successor, are still committed to creating a world-class state education system by; giving greater autonomy to schools, improving parental choice, offering more support for the poorest, whole system improvement, and great quality provision for children (DfE 2011b).

The context of this research project focuses on the impact of design and specification decisions during major works on subsequent post-occupancy processes; the routine maintenance and management of the building premises. It also explores the relationship between the main stakeholders and how this impacts decision making and post occupancy operation of school buildings. The study builds on previous research (e.g. Zhang and Barrett 2010) with the aim to further refine and map the key design factors that affect post occupancy evaluation, operation and maintenance in school buildings. The scope of this study was restricted to primary and secondary school buildings in the Sussex region initially and the data was provided by a representative steering group, consisting of stakeholders in the Sussex County.

This paper starts with an overview of post occupancy performance factors. The paper then presents findings derived from a stakeholder forum, which focused on post occupancy work carried out to either adapt or extend school buildings and facilities. These major works are either due to performance failure of certain parts of the building, or decommissioning, upgrading the key spaces, increasing capacity and so on. The funding mechanism in public schools places the responsibility (and funding) for major works on the funding bodies, which in most cases are the Local Authorities. These types of work are different from the routine maintenance, operation and servicing of school buildings. Post occupancy minor works are the devolved responsibility of the individual schools.

Documents such as the Building Bulletin 98 and 99 (DfEs 2004; DfeS 2006) define the client team broadly to include; fund holders, senior school staff, building professionals as well as staff and pupils. For this research, further distinctions are made thus: the Local authority and other fund holders, are the Client, the designers, contractors are Building Professionals, and the schools, as represented by the facilities/premises officers, bursars, governors, business managers, head teachers, are generally referred to as User in the paper.
Post-occupancy design processes

Buildings in general are subject to performance deficiencies in performance and sustainability and it is often necessary to introduce post-occupancy interventions to minimise those defects (Douglas 2006). The process of change often results in (Douglas 2006; Addy 2004): poor quality buildings/facilities, non-functional spaces e.g. narrow corridors, insufficient capacity etc., new and untested products/materials, buildings that offer no flexibility to their users, are not future-proofed, difficult to operate and use, and difficult to maintain. In certain instances, loss of value may also be inevitable due to: design and development briefs that give no flexibility to the design team, inappropriately high quality standards, and delays in decision making, the use of one off design solutions, poor information supply and unmanaged change (Addy 2004). The response to diminishing building performance depends on building users, asset and value expectations and statutory requirements, for example, health and safety. For the purpose of the current research and in this paper, all the activities which involve any change at post-occupancy stages are referred to as post-occupancy design processes. These include conception to completion of any building work or upkeep activity while the building(s) or facilities are still in use. This definition excludes disassembly, demolition or decommissioning of buildings.

![Post occupancy spectrum](image)

**Figure 1 Post occupancy spectrum (after: Douglas 2006)**

Post-occupancy building performance is about providing an environment that supports the activities of the occupants; providing delight and inspiration, with low impact on the environment in the long and short term, cost effective to operate and maintain and which is robust and flexible enough to adapt to changes (Pegg 2009; Hadjri and Crozier 2009). There are two elements to performance management; interventions for performance upkeep i.e. maintenance and repairs, or for performance adjustment, including building adaptation work (Figure 1, after: Douglas 2006). Interventions as a response to diminishing building performance is influenced by both qualitative and quantitative factors including; asset and value management criteria, statutory requirements for sustainability, health and safety etc. as well as user requirements (Ornstein et al 2009; Douglas 2006). However, qualitative (subjective) considerations can sometimes be overlooked to favour quantitative benchmarks (Preiser and Vischer 2005), thereby focusing more on function than functionality.

For schools, buildings and associated facilities are essential assets for ensuring and maintaining educational standards as well as the health, safety and welfare of its users. Hence, schools facilities are periodically reviewed and their operations are subject to rigorous statutory requirements by governing authorities. The effective delivery, maintenance and operation of these assets throughout their lifecycle are therefore important. Post occupancy processes include operation, maintenance
and management of buildings. This is often complicated as a result of the high number of stakeholders involved, the funding and responsibility hierarchy and the complexity of space functionality. Performance requirements as well as legal and liability-related issues and requirements also need to be taken into account.

Preiser define Post-Occupancy Evaluation (POE) as a process of systematically evaluating the performance of buildings after they have been built and occupied for some time (Preiser 2002, p. 42). POE is carried out to fulfil a number of purposes (Whyte and Gann 2001; also: Hadjri and Crozier 2009) and is based on feedback and evaluation at every phase of the building ranging from strategic planning to occupancy, throughout the building’s life cycle (Preiser and Vischer 2004 p3). Similarly, building performance evaluation (BPE) is a method for acquiring necessary information and knowledge for the efficient planning, design, construction and occupancy of buildings. This is based on three priority levels for building performance: Health, safety and security performance, Functional, efficiency and work flow performance, and Psychological, social, cultural and aesthetic performance. Some BPE tools used at the pre-construction phase include the BRE building performance cost-in-use model, as well as value management and technical audits.

In general terms, Whyte and Gann (2001) suggest a number of plausible benefits for conducting a POE. These include: applying design skills more effectively, improving commissioning process, improving user requirements, improving management procedures, providing knowledge for design guides and regulatory processes; and the proper targeting of refurbishment. In spite of these benefits and an increasing global interest in building performance assessment and POE, such assessments are simply not undertaken, or results are not routinely available or used widely by most design and building teams (Bordass and Leaman 2005).

In this research, the focus aligns with obtaining performance feedback on quantitative (building) and qualitative (stakeholder) level. According to Vischer (2001), this focuses attention on the rigorous standardisation of collecting feedback, suggesting that such information should be focused on “a few, carefully selected and identified indicators of environmental quality”; recommending procedural steps that reiterate the need for standardised data gathering, but also include the requirement to balance qualitative and quantitative datasets, as well as establishing the nature of the focus group to which the information is to be disseminated (Vischer 2001, p. 33). The model proposed by the stakeholder forum at the end of this study is aimed at filling this procedural gap.

**Post occupancy design factors**

The following factors, identified from existing literature, have impacts on the continuous and efficient performance of buildings; including school buildings. These factors are broadly categorised as; poorly defined design intent (Perelman et al. 2001, Green and Simister 1999, Kelly et al. 2005), poor design decision making (Kelly et al. 2005), inadequate information and knowledge processes (Bouchlaghem et al. 2004, Gigerenzer 1996, Galbraith 1977, Koutamanis et al. 2008, Quanjel and Zeiler 2007), inefficient collaborative working practices (Bertelsen and Emmitt 2005, Emmitt and Gorse 2003, Kalay 2006) and ineffective performance monitoring (CIB 1993, Preiser 2002, Cory 2001). Each factor highlights the importance of post-occupancy evaluation processes in which performance monitoring plays a key role.
• **Performance monitoring**

Performance monitoring and management is an important task in facilities management. The performance concept is a more systematic way of determining and achieving desired results by focusing on ends rather than means (CIB 1993). It is important to evaluate and understand the impact of the design on building performance i.e. functional activities when the building is operational (Figure 2), hence, the definition in BS 5240 of building performance as behaviour of a product in use.

![Building performance timeline](image)

**Figure 2 Building performance timeline**

Building diagnostics is the systematic study and evaluation of building performance. The reason for information acquisition in buildings is to capture and represent the passage of time (Giaini 1999) as well as to visually or digitally document the evolution of building: form/ structure/ elements/ components, in order to maintain, preserve or enhance its use. In the hope that the final outcome will be beneficial for acquiring and processing information usable for designing, evaluating, improving or repairing building infrastructure (Cory 2001).

For existing building works, a complete diagnostics or condition survey is generally carried out during the preliminary stages and findings are incorporated in the brief. A more holistic approach is needed in order to assess how well a building is behaving overall and in the long term. However, the predictability of total building performance is relatively low. That is why most of the early and ongoing studies have concentrated on measuring and assessing the performance of building products rather than whole buildings (Douglas, 2006). As the understanding of total building performance increases, the list of mandates employed can be refined and stakeholders involved in the value chain or in the design process of the building, regulators and building users, can express performance requirements. These requirements, both in relevance and in quality, will vary with the stakeholder...
and his/her perspective of interest. The prioritisation of requirements should be within the context of the property concerned and based on the needs of the users.

- **Design intent/criteria**

Design criteria are the explicit goals that a project must achieve in order to be successful (Perelman et al. 2001). It is often in the form of a document which stipulates in a clear and concise manner, the client’s value and functionality requirement. In post-occupancy work, a process of requirements definition, analysis, tracking and verification defined with stakeholder involvement is crucial (Kamara et al. 2002; Lee et al. 2005). Through appraisals, feasibility studies and performance evaluations, the design and decision criteria are defined and enumerated in the briefing documentation. This information and knowledge process affects the success and failures of building performance interventions in school facilities. Information and knowledge captured during POE and BPE are therefore crucial for preparing realistic project and performance specifications such that when decisions are being made, efforts are made to balance these criteria to satisfy both client and users. The briefing documentation defines the design intent and it is often implemented in two stages. The first is referred to as strategic briefing and is concerned with understanding the client’s business processes and expectations. The second stage comprises the conceptualisation of built solutions and issues of performance specification (Green and Simister 1999).

- **Information and knowledge for design decisions**

Buildings are a complex arrangement of systems and sub-systems. Therefore, design and management decisions require timely, usable and reliable knowledge and information flow. Galbraith (1997) said that a basic proposition is that the greater the uncertainty of the task, the greater the amount of information that has to be processed between decision makers during the execution of the task. Kelly et al. (2005) suggests that the different stages of briefing require different information, expertise and knowledge. Stating that at the second stage for example, the decisions require a more detailed understanding of the operational characteristics of the proposed built facility and more detailed input as to their construction implications. According to Björk (1999), information-related processes in building projects will consist of person-to-person communication, creation of new knowledge, information retrieval and storage, then making this information available. The utilisation and management of information also requires context. The contextual situation of an existing school contributes to its complexity and uncertainty. The amount of information retrievable during the life-cycle of the building reduces the level of dynamic uncertainty. And significantly improves the quality of decisions.

Design quality indicators (DQIs) and performance metrics are used to provide a complete and coherent representation of both design intent and the basis of design (Hitchcock et al. 1998). Therefore, selection of performance criteria has to be done within the context of the property concerned and be based on the needs of the client and its users (Douglas 2006). Performance indicators contribute towards realising value for money, for and on behalf of the client and helps to determine specific information requirements for the project. Within this performance framework, a design team can retrieve existing information and request additional information to close information and knowledge gaps. Koutamanis et al. (2008) identified additional requirements for design information to be information integration (of many aspects at a given moment in a process) and continuity (throughout a process). Communication and interaction between different aspects
and the corresponding disciplines and stakeholders can only improve with the correlation of the information each aspect requires or produces (Koutamanis et al. 2008).

**Figure 3** Typical design information and decision structure

In addition to quantitative metrics, experience underlies the process of decision making. Experience acquired through the practice of design, maintenance or management of a building can be considered to be more readily available, acceptable and quicker to use. The importance of school premises officers and caretakers cannot be overlooked for this reason. It can be argued that one can minimise design failures in school projects by implementing an effective knowledge and information sharing process to achieve an integrated tacit, quantitative and semantic framework (Quanjel and Zeiler 2007).

- **Collaborative working practises**

  The overhaul in the School Building Programme in the UK resulted in increased decentralisation of decision processes through devolved capital budget and responsibility to the local governments and devolved maintenance budgets directly to schools. This on one hand has led to better utilisation of information scattered throughout the lower levels of the firm’s hierarchy (subject to effective information and knowledge management) but on the other hand loss of control for the upper level managers (Zabojnik 2002). With increasing number of active role-players, there is increased complexity in roles, responsibility and liabilities of decisions and consequences. Understanding stakeholder issues is therefore important for implementing effective post-occupancy building work in this context. The blend of perspectives obtained through evaluation or consultation processes can positively inform recommendations regarding interventions and maintenance programs for the
buildings (Ornstein et al. 2009). Early collaboration will also ensure that lifecycle performance requirements are effectively captured from schools managers and users, the main beneficiaries of the work, while the work is implemented within value expectations of the client – often the local authority.

Even though participants in a building work may be short-termed compared to lifetime of the building, the effects of their collaboration, in terms of the decisions they made and the action they have taken when they were part of the project team, may well impact and constrain the freedom of action of other participants long after the original participants have departed (Kalay 2006). Working closely with affected stakeholders in this sector, this research investigates post occupancy intervention problems from the stakeholder perspective. Through stakeholder input, it then reviews the flow of information and the exchange of knowledge during the conceptualisation stages of post-occupancy interventions/work; who is involved, when, where and how. This is to explore the supposition that design decisions made in isolation, using tacit, physical or semantic information alone (Figure 3), often yield less desirable results. The study also explores the long term consequence of capital project decisions (by the client) on the day-to-day operational and maintenance activities of school buildings (by the user). It then highlights the need for lifecycle factors in the cost-benefit considerations for post-occupancy evaluations in schools.

**Research methodology**

This study utilises a qualitative approach, starting with literature review. Qualitative research methods deal with narrative data and interpretive epistemology and involve the systematic collection, organisation, and interpretation of textual material derived from talk or observation. Positivist and phenomenological approaches were used during literature review, the former for knowledge acquisition and the latter for understanding trends and phenomena.

In addition to literature review, the primary data for this study was obtained from a steering group (stakeholder forum) comprising of a sample of primary and secondary school representatives, local authority representatives and building professionals. The term steering group, instead of a focus group, is used because a focus group generally refers to a one-off group of people whereas a steering group informs a research/study program over a period of time. Sampling is the first stage of measurement where the selection of a few (a sample) from a bigger group (the sampling population) becomes the basis for estimating or predicting the prevalence of an unknown piece of information, situation or outcome regarding the bigger group (Kumar 2005).

Invitations were sent to 60 randomly selected private and public, primary and secondary schools in the Sussex area. In addition, another 20 invitations were sent to the relevant local authority departments and building professionals. 2 design/academic experts were also invited to serve as advisers.

The result is a total of 13 members in the steering group. The composition is as follows:

<table>
<thead>
<tr>
<th>Job roles</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facilities manages /premises offices</td>
<td>3</td>
</tr>
<tr>
<td>Buildings experts (architect, engineering consultants)</td>
<td>2</td>
</tr>
<tr>
<td>Finance/ Business managers/Bursars</td>
<td>3</td>
</tr>
</tbody>
</table>
The composition of the steering group was accepted to be representative of the key decision stakeholders for major and minor works in a school project. Therefore, the findings from the steering group meeting can be generalised even if there may be procedural or implementation variations at the local or individual school level in Sussex.

This paper is based on findings from 2 steering group meeting each lasting at least 5 hours. In both instances, minutes of the meetings were also circulated to members and corrected for errors where appropriate. The analysis was also conducted in two stages. First, the textual data from the first steering group meeting was analysed for content and context. This was done by identifying recurring terms, themes and factors that related to, or affected each theme. This resulted in thematic clusters which identified both contributory and consequential factors that related to each theme. These findings are then tabulated and fed back to the steering group at a second meeting. This second stage was to check for accuracy of content and interpretation.

The following sections present the qualitative findings from the analysis of text data obtained from the first steering group meeting. The findings were subsequently triangulated using a design criteria checklist, completed by 7 steering group members, to clarify points raised during the discussion. A basic model was then developed as a guide for requirements and decision mapping in post-occupancy design decision processes in schools.

**Findings**

During this meeting, post occupancy building work and associated processes were discussed. Particular attention was given to the users’ performance expectations after completion of works. The topics centred on stake holder relationships, lifecycle processes, public expectation and government standards, and lastly, funding and resources compared to cost and investment. Steering group members also presented anecdotal evidence to support the main points raised during the discussion sessions. Questions during the meeting gauged the extent to which current experiences and practices for procurement, brief development, and the delivery of the work falls short of expectations. Focussing on:

- The work and associated decision making processes
- What is the decision making hierarchy?
- What is needed to achieve the client and user requirements?
- Who is responsible?
- What resources are required? and;
- To what extent does this affect decisions, processes and procedures locally in schools?

To summarise, steering group members agreed that the performance of school buildings is based on whether:
The buildings and associated spaces and site support the teaching and learning activities and provide inspiration to staff and students.

- The building and its facilities are safe to use and promote health and welfare.
- The facilities are optimised for resource use e.g. energy and water and has a low impact on the environment in the long and short term.
- The facilities are cost effective to operate and maintain.
- The spaces are adaptable to changes.
- The building fabric and materials are robust, durable and require low maintenance.

The main outcome of the meeting confirmed what was found in literature, putting particular emphasis on some aspects more than the others. All the steering group members agreed that post-occupancy processes are affected when:

- Briefing process is not robust and all encompassing
- Design intent is vague and unclear – because of the disparity between what designers think is best and what the users want.
- Whole life impact is not considered when making design, operation, maintenance and cost decisions.
- Buildings and spaces are not future-proof; not adaptable or flexible.
- Building systems, materials etc are not durable, fail or fall short of performance expectations.
- Design and construction do not meet maintenance requirements.
- User knowledge and information are not captured and utilised during design decisions. In general, when flow of information and the sharing of knowledge is poor.
- Non-inclusive and non-collaborative working among key stakeholders during the early stages of the decision making process which in turn leads to conflicts and problems during the post-occupancy stages.

In line with the post occupancy factors identified from literature, the steering group further enumerated on these points as follows:

1. **Design intent and brief**

   From the client (Local authority) perspective, the brief is vital and this is often based on the Building Bulletin - BB98 and BB99 which specifies design criteria. Partnerships for Schools (PfS) are in the process of revising BB guidelines and the user teams within the steering group expect that spaces will be downsized in the revised version while schools will generally like spatial allocation to increase.

   However, poor briefing strategy was the main issue emphasised by the schools represented in the steering group. They argued that they had little or no user involvement in briefing process or design decisions, stating that when defining design intent for projects, there is generally an over reliance on expert competence and advice, compared to finding out more about user needs or the buildings' lifecycle requirements.
2. Information and knowledge for design decisions

The steering group felt that it was important that clients and building professionals take into account the fact that most schools are run by people who are not primarily building experts. Therefore, buildings should be delivered to facilitate the ease of use and maintenance. The steering group highlighted that design choices such as the use of untested design/materials can be avoided if the flow of information and knowledge from schools to the development team is better.

The presentation and timely availability of design information especially drawings is also important. Some schools said that they often do not have the latest and up-to-date schematics of their site. This dissociation between design communication (drawings) and finished building often results in time wasted on finding out where things are or how they are assembled when maintenance or refurbishment work is to be carried out. The manner in which information is disseminated can also be a challenge with non-integrated data/information sources and disparate types and formats. Poor communication/information for building operation and maintenance especially during handover were also mentioned. “Updating information regularly is also important and this needs to be resourced; there is also the need to determine who does this and how it is done. Lack of information, what is where, is an issue and it causes problems”.

The lack of continuity in information processes for learning and knowledge transfer was also identified. “Pragmatic considerations need to be captured and brought up as an alert. Before it becomes a problem...” “Schools are built in waves. There are now loads of knowledge in the system but we are not translating that for future uses. Schools are still used as guinea pigs to test out new materials, design”.

One steering group member stated that “it is unfortunate that new buildings do not often translate to better buildings”. Mentioning that the decision making process and the decision hierarchy was too complex to be effective. “There are all sorts of decision processes and difficult to know who makes the decision... who makes the FINAL decision”. Some stated that decisions are also often based on cost and not value. Comments include; “There is no consideration for lifecycle impact. Lack of consideration for building operation and management e.g. implementing passive design is an issue”. “No future-proofing. Classrooms are designed for exactly 30 students as specified in the building bulletins etc, what do you do if you have 31 that year? At our school, we need to have 3 half-hour dinner sessions, because of the lack of space”. “It is often the long term consequences of short term decisions. Lack of communication, lack of the implementation of feedback; the council goes for the cheapest tender leaving the school to pick up the maintenance tabs”.

User teams will also benefit from an understanding of cause and relationships, which will aid decision making processes in school works. Examples given include:

- Effectively communicating the prioritisation of work so that disruption is minimised
- Benchmarking with similar schools, so that best practice is learnt and mistakes are avoided
- Provide context for data and information. Some data or information is not often useful otherwise.
- Material properties/ specifications should be linked up with maintenance logs. This way, recurring problems from using non-performing materials are avoided.
- Being able to have a shared rating system for contractors on the approved list.

3. Collaborative working (and feedback)

Similarly to what was found in literature, steering group members identified that lack of effective communication, and poor communication/consultation, between major parties as crucial factors with post-occupancy consequences. Lack of collaboration in design decision making also leads to design quality standards/criteria that are dissociated from user/client criteria. Although sometime, dialogue takes place to achieve compromises in the differences in designer/user/client/regulators expectations, majority of steering group members agreed that managing expectations of the various stakeholders is often a challenge.

4. Building performance

Old buildings have different operation and maintenance requirements but steering group members generally stated that their old buildings often perform better than newly built ones. One reason is the use of untested methods and materials. “The consequence is that the building users need to perpetually deal with design-induced maintenance cycles and costs which further stretches already limited resources”.

The performance of spaces was also highlighted as important. Poor spatial design such as; narrow corridors, inadequate communal spaces, poor teaching rooms were mentioned often. “We are constantly dealing with non-functional spaces and facilities”. “The room design capacity... the design lacked growth factors”. Also, “The design – roomy, airy, heating, natural ventilation are important design factor right? Our new building has an air conditioning system in it!!” In addition to maintaining the fitness for purpose and the daily functions of the building, the steering group stated that the need to comply with ever-changing legislations could be a challenge. Buildings need to be kept in compliance with building codes, health and safety regulations etc.

Contribution from findings

In addition to the previous factors from existing literature, three additional factors were identified to have crucial impact on post occupancy evaluation, operation and maintenance in buildings:

a) Quality and competence of design, construction and workmanship

Some of the stakeholders had poor opinions of architects based on recent experiences in school projects. The perception was ascribed to poor communication between both parties and the general perception that some architects will not consider user requests or experiential evidence when making design and specification decisions. This combined with the perception that apart from cost, the client and design team often consider aesthetics above functionality.

The main problems experienced in recent projects include poor, non-functional design or poor build quality caused by design complexity leading to more defects than is necessary. “If it is difficult to build, it will be difficult to maintain”. This leads to one problem after the other;
“Under floor heating – gone wrong. Inverted roofs! Aesthetics over functionality, regular clogging of the drain pipes has cost implications. We are constantly making operational adjustments or rework to fix design errors. A building that is over budget but still poor design is difficult to justify”.

b) Procurement and Budget constraints

The clients represented in the steering group highlighted the challenges of balancing the demand to provide adequate and sufficient school places, with the user requirements within limited funds. Due to the economic climate, there are funding/ budgetary constraints and the capital expenditure (CAPEX) budgets are much reduced compared to previous years. Therefore, it is inevitable that in most cases procurement strategies will result in contracts awarded based on cost, just to meet the need. The schools argue that the cheapest tender often translates to higher maintenance costs and framework or partnering agreements do not always guarantee value/quality.

The other points raised by the schools are that some agreements make latent defects with warranties/liabilities difficult to enforce and in recent times, with increasing contractor bankruptcy, many schools are left with the cost and burden of remedial work in addition to the high maintenance and operational costs due to poor design and construction decisions.

c) Time (lead-in time)

The client (local authorities in most instances) indicated that it is not always possible to allow adequate lead-in period for proper evaluations, consultations and brief development. All members of the steering group will like this to be the case, stating that inadequate lead-in time often leads to higher levels of latent defects and liabilities: “If the time is spend fine tuning the design brief it works, especially if there is time to go through the design evolution process…”

To further check and triangulate the points raised during the meeting, steering group members were asked to complete a checklist to prioritise the design criteria raised during the meeting. Seven members completed and returned the checklist. The high show factors which were considered by respondents to have the highest impact on post-occupancy operations of their schools. The results are summarised in Table 1.

Table 1 33-point design priorities according to the steering group

<table>
<thead>
<tr>
<th>DESIGN CRITERIA</th>
<th>LOW (COUNT)</th>
<th>MEDIUM (COUNT)</th>
<th>HIGH (COUNT)</th>
<th>COMBINED PRIORITY</th>
<th>SPECIAL REQUIREMENTS/COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Functional and safe external spaces</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>Medium</td>
<td>Safe external spaces in terms of liability</td>
</tr>
<tr>
<td>2 Internal spatial capacity e.g. teaching rooms, halls</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>3 Ventilation</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>4 Thermal comfort</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>5 Passive systems (for services)</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>Medium</td>
<td>Message to users important</td>
</tr>
<tr>
<td>6 Flexible and adaptable spaces</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>Medium to High</td>
<td>Health and safety issues. Compromises to the design/ space</td>
</tr>
<tr>
<td>7 Functional communal areas</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Medium to High</td>
<td></td>
</tr>
<tr>
<td>DESIGN CRITERIA</td>
<td>LOW (COUNT)</td>
<td>MEDIUM (COUNT)</td>
<td>HIGH (COUNT)</td>
<td>COMBINED PRIORITY</td>
<td>SPECIAL REQUIREMENTS/COMMENTS</td>
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<tr>
<td>8 Easy access to services (e.g. for maintenance)</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>High</td>
<td>Consider volatility of capacity in terms of the demands of spaces</td>
</tr>
<tr>
<td>9 Quality build – durability and ‘maintainability’</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>10 Functional circulation spaces e.g. corridors</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>11 Accessible and inclusive spaces</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>12 Systems that are easy to operate e.g. lighting, heating</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>13 Easy of maintain</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>14 High quality, durable products and materials</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>High</td>
<td>Yes – for the vital aspects of the building. Sharing of knowledge also important</td>
</tr>
<tr>
<td>15 Standard products and materials</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>16 Fitness for purpose</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>17 Future proofing</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Medium to High</td>
<td>Medium – subject to affordability – ’at what cost...’</td>
</tr>
<tr>
<td>18 Context-based design solutions e.g. considering site constraints</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>High</td>
<td>Explore opportunities</td>
</tr>
<tr>
<td>19 Health and safety compliant (life-cycle where possible)</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>High</td>
<td>How best to implement extensions to ensure that things still work</td>
</tr>
<tr>
<td>20 Promotes staff and student well-being</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>High</td>
<td>Retrofitting to improve well being</td>
</tr>
<tr>
<td>21 Value for money (using life-cycle criteria)</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>22 Complies with building regulations and other statutory requirements</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>23 Design intent delivery client/user requirements</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>24 Aesthetics</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>Medium</td>
<td>[Council] depends on how much money is available – funding limitations (basic need cost multiplier), and how it links with other criteria</td>
</tr>
<tr>
<td>25 Sustainability – energy, water, materials etc</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>26 Integrate cutting edge building technologies</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>27 Minimum disruption during term time</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>Medium to High</td>
<td>Managed works</td>
</tr>
<tr>
<td>28 Quality of amenities</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>Medium</td>
<td>Avoid over-spec schools, lots of unused spaces</td>
</tr>
<tr>
<td>29 Community integration</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>30 Campus as a teaching school/ teaching aid (e.g. sustainability, horticulture)</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>31 Easy understanding and control system</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>Preferred</td>
<td></td>
</tr>
<tr>
<td>32 Right development team/ right blend of professional advice</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>33 Precedent studies prior to development</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

**Discussion**

The findings from the study proposed three additional factors, in addition to the five important post occupancy factors identified in literature.
Quality was defined in terms of the quality of the professionals as well as the quality of the work. Incidentally, the quality of design professionals was not rated based on their ability to conceptualise aesthetically pleasing buildings, or buildings that comply with the Building Bulletins. From the user perspective, the quality criteria are defined by the performance and functionality of the building. This they further defined as a building that fits its context as well as adequately sized and functional spaces that are fit for purpose was not always achieved in major works. Quality of materials and workmanship was also considered important which links in with the issue of budget and costs. The user team expects that the best value products are specified. By best value, they mean durable products and materials, which is easy to operate and require little or no maintenance. Emphasising that the quality of design and installation may affect the longevity or increase the need for maintenance of some design provisions.

Sustainability and internal comfort were considered important. Schools must comply with health and safety regulations. Ease of access and operation of building services can help to facilitate this process and schools felt that sometimes, keeping systems simple and usable helps.

The steering group agreed that the value consensus can be achieved if the user team are effectively consulted and their knowledge of managing and maintaining the building is taken into consideration. A study presented in (Bordass and Leaman 2005) found that there is a general interest in feedback: many clients had undertaken feedback exercises of some kind, though seldom systematically. This interest was confirmed by the steering group for this project. The study also found that POE for stakeholders was more than an assessment of the quality or performance of the design. For the stakeholders, the emphasis is how design decisions and specifications affect operation and maintenance processes.

The quality of information gathered at the appraisal stages was considered vital. The group stated that the condition survey will be more useful if it is a live document, rather than something produced periodically. Some members of the group stated that documentation on the condition of their building is often 2-4 years out of date, which might be a long time depending on the building development plan. Lastly, a pressing need for a system to assist in the streamlining of information flow (particularly upwards, from the schools to the LA) and management of knowledge to facilitate design decisions was identified.

**Post occupancy process model**

Process modelling is an established method of research investigation which is used to define, support or improve practises or processes in different subjects or disciplines. Roland (1993) proposed three abstraction levels in process modelling; (1) Development runs (what happens), (2) Process meta-level (Generic concepts) and (3) Process model (Ways of working). This paper investigated the first level ‘what happens’ and makes a contribution to the second level through a process model which highlights important factors to improve ‘ways of working’. Following on from literature search (e.g. Vischer 2002) and to further integrate the steering group findings, the simple model is proposed as a procedural prompt to stakeholders especially at the inception stages of school building work (Figure 4).

The model recommends the need for decision processes to be more integrated, collaborative and inclusive. It also acknowledges that decision making in post occupancy evaluation, operation and
maintenance in buildings is an evolving process. Allowing sufficient lead-in time information and knowledge gathering and also making the condition survey a live document will help to improve the briefing process and will ensure that user performance expectations are considered. Value was rated higher than cost alone, so in expert processes, it is equally important to go for best value tender based on clearly defined objectives.

Figure 4 Simple procedural model for post occupancy processes

The model also acknowledges the value of linking up design criteria with operational criteria, and that the proposed design and design intent take account of life-cycle operational/maintenance issues. Prioritisation is an important decision making tool but the steering group also placed value on ‘getting it right the first time’ and understanding dependencies in building activities will help to achieve this. This will also help avoid scheduling conflicts, hence, the priorities, scheduling and depend factors highlighted in the model.

For feedback among stakeholders, the procedure prompts for knowledge to be captured and fed into the design decision process to avoid repeated mistakes. Alternatively, an advisory system (or toolkit) could be enacted to flag up knowledge requirements. Openness and transparency will create better communication and working relationship with the LA and between schools and collaboratively help improve the design, delivery and long term performance of school buildings.
Conclusion
The paper reported on initial findings of a study on the impact of design decisions on post occupancy processes - evaluation, operation and maintenance in schools. The paper represents the findings of the development process of this research project which in return will be used for the next stages of information and knowledge management solutions. The qualitative and quantitative data directly obtained from a retained steering group, confirmed that design intent and brief, decision methods, information and knowledge processes, collaborative working among stakeholders and performance monitoring affect post occupancy processes. In addition, the findings also argued that quality and competence of design, construction and workmanship, procurement and budget constraints as well as allowing sufficient time will improve building delivery process in general. A diagrammatic model was then presented to integrate the findings.

This study particularly found that effective information and knowledge capture i.e. no one-off POEs, strategic involvement from stakeholders, a design brief that integrates existing information and knowledge and is primarily influenced by the long term operation and maintenance requirements of the school facilities will ensure that post-occupancy interventions deliver value – quality and cost effectiveness for the benefit of its users. It was concluded at this stage of the study that integrating stakeholder views and preferences may add complexity but it is essential to achieve function as well as lifecycle functionality of post-occupancy interventions. Positive collaboration can be achieved through: Reciprocity: a continuous collaboration, updating, feedback and sharing process and, Transparency: clear accessibility for different user levels subject to legal and liability issues. A well implemented information and knowledge process will supply validity and reliability to decisions processes: by supporting a seamless, continuous approach for information sourcing, storage and retrieval to improve availability of data and participation of a wider range of lower-level stakeholders e.g. caretakers and integrating knowledge and information processes.

Based on these findings, the next stage of the research is to implement the information aspects of the procedural model by developing a solution which will facilitate the process of:

- including numerable criteria and possibilities in the briefing process
- Involving ‘on-ground’ staff in briefing process
- Identifying spatial relationships, cause and effect
- Guaranteeing knowledge and experience is passed on
- Conducting future projections based on up-to-date building data

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References


