IMPROVEMENT OPPORTUNITIES FOR EVIDENCE-BASED DESIGN: AN APPLICATION OF A CRITICAL REALIST'S PERSPECTIVE

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Both industry and academia consider Evidence Based Design (EBD) to be a positive way forward to improve the quality of the health service through better utilisation of rigorous evidence during the design process. The use of rigorous evidence is not a distinct activity of the design process; it materialises on different routes and activities scattered throughout the design process and which presents many prospects for improvement. The aim of the reported research is to identify how the evidence based design process could be improved. The research takes a critical realist's perspective. An overview of evidence based design, and critical realism are discussed in the back ground literature. Twelve semi-structured interviews with professionals working on healthcare built environment projects were used to gather data pertinent to their choice and application of different sources of evidence. Results validated a conceptually derived model of current practice of EBD and highlighted prospects for improvement. Interviews were thematically analysed to identify the rationale behind current practices and such themes were then used in deriving mechanisms and contingent conditions of the EBD. Six mechanisms that are causally efficacious prospects for improvement and four contingent conditions that flourish or suffocate these prospects were derived. Several suggestions are proposed several to improve EBD in the UK together with a discussion of the experience of adopting a critical realist's approach.

Keywords: critical realism, design, evidence-source, healthcare.

INTRODUCTION

With the ambition of improving health outcomes through built infrastructure, evidence based design has captured attention of the researchers for the last three decades. The research reported in this paper forms part of a three PhD programme based in the Health and Care Infrastructure Research and Innovation Centre (HaCIRIC). The purpose of the overall research is to identify improvement opportunities for evidence based design for healthcare. In the first phase of the research, interviews were conducted to establish EBD current practice and identify the rationale behind it. The EBD current practice has been articulated into a conceptual model which has been previously presented in detail (Wanigarathna et al. 2012) and is summarised briefly in this paper. This paper mainly discusses the analysis of the rationale behind current practice to identify mechanisms and contingent conditions of the EBD, while explaining how critical realist view applied in this research.

Wanigarathna N, Price ADF and Austin SA (2013) Improvement opportunities for evidence-based design – an application of a critical realist's perspective *In:* Smith, S.D and Ahiaga-Dagbui, D.D (Eds) *Procs 29th Annual ARCOM Conference,* 2-4 September 2013, Reading, UK, Association of Researchers in Construction Management, 903-913.

EVIDENCE BASED DESIGN

It has long been recognised that the surroundings of patients can affect their healing, for example, Florence Nightingale's (1820-1910) notes reveal her experience of how surroundings impact on healing. Prior to the last three decades, most of this knowledge was based on anecdotal evidence, however, during the 1980s, a growing body of rigorous research has investigated how built infrastructure can impact on physical, physiological, psychological and behavioural outcomes of staff, patients and other users (Codinhoto et al. 2009; Ulrich et al. 2008; Phiri 2006). Evidence Based Design (EBD) emerged as a concept of healthcare design to increase the use of rigorous-research evidence. In addition to health outcomes, EBD is also argued to support whole life value savings, operational efficiency (Berry et al. 2004) and innovation (Lawson 2005; Suttell 2007) for healthcare and provides a competitive advantage for its users (Stankos and Schwarz 2007; McCullough 2009). EBD is now recognised as good design practice that can be used for the design of other locations such as offices and learning environments (Hamilton and Watkins 2009).

Evidence as in EBD stands for up-to-date research based knowledge, derived through the highest rigour as defined by the world view within which research is conducted (Moore and Geboy 2010). Such evidence can be generated by researchers in academic and other research institutions as well as practitioners in the industry. Opportunities for the practitioners to produce rigorous evidence is claimed to be restricted and most rigorous evidence is currently generated by researchers and published in peer-reviewed journals (Hamilton 2010). However, uptake of such evidence is limited for reasons related to lack of time and cost resources in accessing them (Martin and Guerin 2006 and 2007; Lawson 2010; Becker and Parsons 2007) and practitioners' negative perceptions about the effectiveness of such evidence (Lawson 2010; Dijkstra et al. 2006; Stankos and Schwarz 2007). The aim of this research was to identify ways to increase the utilisation of rigorous research evidence during the design process.

RESEARCH METHODOLOGY - CRITICAL REALISM

Researches contained in the peer-reviewed journals are not a primary source of evidence in designing. However, research could be disseminated in the design process through alternative routes. Exploring the rationale behind designers' choice of different sources of evidence would disclose prospects for different routes of EBD. This view of analysis follows the philosophy that of critical realist's.

Critical Realism (CR) is a philosophy derived primarily from the work of Bhaskar and his colleagues (for example: Bhaskar 1978; Archer 1995). It has since been adapted, developed and described further by other scholars (for an example Archer 1995; and Sayer, 1992). Researchers in organisational management and construction management have adopted this world view Ackroyd and Fleetwood 2000; Fleetwood and Ackroyd 2004; Reed 2008; Easton 2010). Ontologically, CR assumes a stratified reality that comprises three strata: 'empirical'; 'actual'; and 'real'. The empirical layer is the socially construed (not constructed) reality observable by individuals, while the actual layer is the events that exist in time and space and the real layer is the social objects possessing a structure and tendencies/mechanisms that are causally efficacious to the production of empirical events (Bhaskar 1978)(see Figure 1). Therefore, CR is an advanced alternative to interpretivism, which often stops the search at socially constructed empirical reality.

Mechanisms play a major role in CR's explanation; these are particular ways of acting (Sayer 1992) or what an entity is capable of doing, or being acted upon, if it is triggered and not prevented by other events (Bhashkar 1978). Mechanisms necessarily exist by virtue of their object's nature (Sayer 1992). Social objects have necessary relationships with their mechanisms. However, the relationships of mechanisms to actual events are contingent upon 'conditions'.

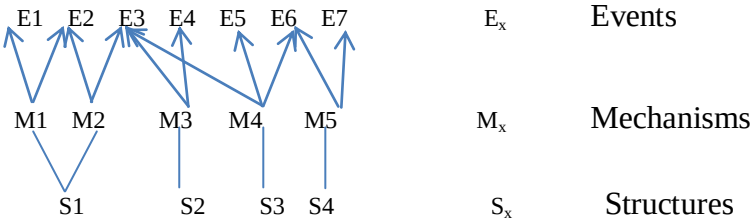

Figure 1: events, mechanisms and structures (source: Sayer 1992)

These are conditioning of causal mechanisms which turns (or fails to turn) causal potential (mechanisms) into a causal outcome (Pawson and Tilley 1997). The existence of a mechanism does not guarantee the occurrence of a particular empirical event; it could flourish or be suffocated by contingent conditions. Epistemologically, CR does not assume privileged access to the 'real' strata of reality (structures, mechanisms and contingent conditions). Bhaskar's classic example for this is that irrespective of our (early) perception that the earth is flat; the earth has always been spherical.

Identifying events at the empirical level provides a good starting point. Yet, the point of CR in social science is not merely to provide an external description but to identify opportunities for change. Researchers need to hypothesise social objects and their tendencies/mechanisms that have the capacity to produce actual events. Identification of a hypothesis for social science phenomena is often considered to be easier than in natural sciences since we have 'internal access', through practice, to many of the structures, mechanisms and reasons and beliefs similar to our own which may function as causes (Sayer 1992). Further, even though natural sciences have a flat ontology over the time (since the universe began), scholars acknowledge the temporal nature of single reality for social phenomena. Bhashkar (2008), in his transformational model of social activity, acknowledges this by explaining the emergent properties of social structures. Archer (1995) and Mutch (2010) explain this temporal dimension through the 'morphogenesis' nature of critical reality. Sayer too (1992) acknowledges the ability to redefine social structures and change the mechanisms/tendencies of social objects by introducing radical changes. On this stance, CR's analysis could identify opportunities to redefine social structures to incorporate better mechanisms that result in more favourable empirical events.

Explicit literature on how to analyse data by a CR method is limited (Bygstad and Munkvold 2011). Sayer's (1992) explanation the reason for this that CR is more concerned about ontology over epistemology and that CR researchers takes a pragmatic approach in search for reality. But, Bygstad and Munkvold (2011) also highlight that this could act as a barrier to novice researchers to follow CR. Therefore, this paper contributes to CR methodology by adding an exemplar application of CR to a construction management research as described in the next sections.

APPLICATION OF CR TO THIS RESEARCH

Research process and research methods

The research followed two steps, identifying firstly current practice of EBD in the industry (empirical and actual levels of reality) and secondly, the mechanisms and contingent conditions behind such practice.

STEP I: Literature, relating to evidence based design and design knowledge sources were used to determine empirical level practice concerning the use of different design information (including rigorous research evidence). These were then summarised in to a conceptual model (see Figure 2) (Wanigarathna et al. 2012) to better illustrate the complicated phenomena. Weak data flows are illustrated by intermittent lines. The model was verified by a series of interviews with academics and validated through industry interviews, even though this process is not discussed in this paper.

STEP II: Twelve semi-structured interviews with professionals working on healthcare construction projects gathered data pertinent to their choice and application of evidence. The reasons for obtaining evidence from four sources and the reasons for not being limited to a particular evidence source were identified separately for the four sources using the model as an aid.

In natural sciences, it is harder to observe mechanisms, but, in social science it is usually possible (Sayer 1992; Bygstad and Munkvold 2011). The rationale identified by interviews was categorised thematically to distinguish logic for each of the four sources of evidence. These were classified as reasons that suggest mechanisms (tendencies) or contingent conditions and subsequently used to postulate mechanisms and contingent conditions that impact the use of evidence from different sources.

RESULTS AND DISCUSSION

Step I - Current practice of evidence-based design (empirical and actual levels)

The model below, derived as discussed in the previous section, differentiates evidence flowing into the design process into four evidence sources (see Figure 2).

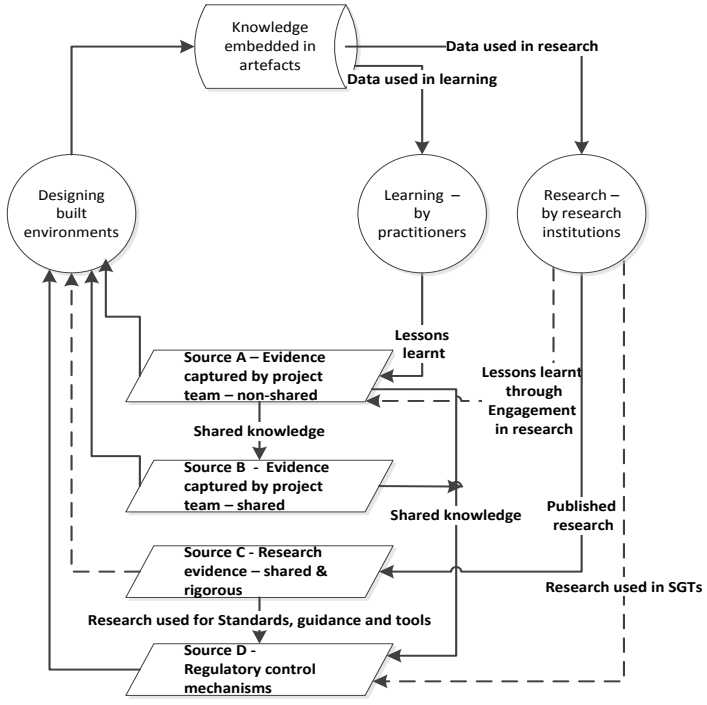

Figure 2 – Process of evidence based design

They are:

Source A: organisational specific non-shared evidence;
Source B: shared evidence from the industry;
Source C: rigorous research evidence; and
Source D: standards, guidance and tools.

Source A evidence is often considered to be anecdotal, resulting from poor data collection and analysis practices due to practitioners' lack of resource to conduct systematic research. Source B evidence is of higher rigour compared to source A, as industry best practice is often been subjected to a certain level of evaluation and has higher levels of reliability due to repeated use. Evidence from source C has the highest rigour and tallies with the definition of evidence associated with EBD. Source C is often constituted of evidence produced by universities and other research institutions. Evidence from source D, includes design standards and guidance (such as Health Building Notes/HBNs, Health Technical Memoranda/HTMs, etc.,) published primarily in the UK by the Department of Health. The rigour of the evidence from source D is dependent upon the base evidence (from either source A, B or C) which supported the generation of the information. Several empirical-level events that would increase the use of rigorous evidence can be identified from the model.

a. Increase the use of source C– identifying the rationale for using types of evidence would help to develop source D evidence into a more practitioner friendly source.
b. Increase the use of source C evidence to produce source D evidence – improve the process of SGT development.
c. Increase the rigour of evidence in source A - improving learning from projects.
d. Increase the flow of evidence from source A to source B– through improved knowledge sharing.

This research is limited to identifying opportunities to improve EBD through 1, 3 and 4, which are related to project level practices. The next sections describe the research methods used to collect and analyse data to identify causal mechanisms and contingent conditions that could bring changes to the practice through 1, 3 and 4.

Step II - Mechanisms and contingent conditions of practices

Table 1 shows the rationale and the limited use of the four sources of evidence, with classification of the rationale as mechanisms (indicated as 'M') or contingent conditions (indicated as 'C') needed critical thinking. Some of the reasons (such as availability of time and money, availability of access) were clearly categorised as conditions. Similarly, weakness (such as incompleteness, inadequacy) of source A evidence sources are clearly mechanisms, i.e. 'exist necessarily in virtue of the nature' (Sayer 1992) of source A. But some were difficult to classify, for example the weakness of some of the evidence sources such as 'evidences are biased', 'evidences are not up-to-date'. Sayer's (1992) explanation of characteristics of mechanisms/ tendencies and conditions for social sciences was useful in determining the status in these situations. He explicates that some interventions are concerned with exercising mechanisms by manipulating the conditions in which they operate, while radical changes could alter social structures (necessary conditions) by virtue of which of the mechanisms exist (Sayer 1992). Accordingly, the reasons that remain largely unchanged over a considerable period of time and thus need radical intervention to change them were categorised as mechanisms (tendencies), whilst those that could be changed within a short period were categorised as contingent conditions. Existing

literature regarding evidence sources were considered to determine the time and effort needed for the change or to determine whether the change would be radical or minor. For instance, EBD scholars suggest that the research evidence base is still growing and thus, will remain incomplete for a considerable period of time. Even a radical change would not be able to remove this inherent tendency. Such reasons were therefore identified as tendencies.

Table 1: Rationale for using evidence from four types of evidence sources

Source of evidence	Reasons for use	Reasons for not being limited to the source
Evidence from source A	- weakness of other resources (M) -for evidence can only be found internally(M) - no faith in knowledge transfer (C) - strong resources found internally(C) - to make an added value to SGTs (M) - to understand what other sources to seek (M) - for project unique issues (C)	- internal resources reflect their own interests (M) - take advantage of additional evidence (M) - inadequacy of internal resources (M) - incompleteness of internal knowledge (M)
Evidence from source B	- can bring expertise in (M) - to select the best available source (M) - inadequacy of internal sources - reliability (M) - to evaluate design (M) - obtain a lot of information (M) - the form and format of evidence (M)	- not tested (M) - unique nature of projects and systems (C) - lack of time (C) - access (C) - different languages (M)
Evidence from source C	- identify best practices (M) - difficulties in producing internally by project stakeholders (M) - characteristics of research (M) - have access through collaborations (C) - to justify the design decisions (M) - ability to afford the cost (C)	- discrepancies of evidences (M) - lack of evidence (M) - not available in a central place (C) - not enforced through SGTs (M) - not easily available (C) - unique nature of projects (C) - academic language and format(M) - need to be supported by operational practices as well (M) - cost and time (C)
Evidence from source D	- legal enforcement (M) - is involved in SGTs development (C) - advantages of standardisation (M) - characteristics of SGTs (M) - other (C/M)	- above SGTs is better (M) - for areas that are not covered by SGTs (M) - not always rigorous (M) - local contextual restrictions (C) - SGTs lagging behind the practice (C) - considered only as a brand (M) - cost (C) - other (C/M)

The following mechanisms and tendencies that were capable of influencing a particular source/type of evidence were postulated through above results.

1. Weaknesses of evidence source require the use of more than one source:
Interviewees revealed the weaknesses inherent in all four evidence sources. Evidence from source A was recognised to be weak because they 'reflect their own interests' are 'inadequate', and 'incomplete'. Evidence from source B was also identified as weak because it was 'not tested' and source C with 'having discrepancies', being 'inadequate' and 'has limitations to results'. Evidence from source D was described as 'some areas of design are not covered by any of them', 'not always rigorous', 'very loose' and 'not up-to-date'. These weaknesses have necessitated practitioners perusing

evidence from more than one source. Therefore, a single source of evidence source does not dominate the flow. Improving the rigour of evidence contained in all four sources is therefore important to increase EBD during the design stage. Specifically, both feeding research evidence (source C) into the SGTs and other sources and increasing the rigour of the evidence produce by project organisations are important.

2. Sources that contain evidence that can be found only in one source confirm the use of that particular evidence source:
Commercially sensitive evidence can be found only in source A, and rigorous evidence contained mostly in C sources. For these reasons evidence from source A and C are inevitably sought by practitioners, unless they are restricted by any contingent condition. This suggests the ability to increase the flow of rigorous research (source C) evidence into the design process, by manipulating contingent conditions (see next section).

3. Evidence in user-friendly forms and formats encourages use:
User-friendly forms and formats of evidence have been identified as a reason to pursue evidence from source B sources. However, some of the evidence was considered less than useful since they are 'not written for the laymen' (source D) and use 'academic language and format' (source C). These views suggest that evidence with user-friendly forms and formats tend to increase their usage. In this respect, databases of research summaries, which are developed to improve the form and format of evidence (for instance, the safer environment evidence-database developed by the UK's Department of Health and the InformeDesign evidence summary database developed by Minnesota University) has a better chance of increasing the direct flow of rigorous research evidence into the design process.

4. Evidence that is legally enforceable encourages use:
Legally enforceable evidence has a tendency of attracting use, but only found in source D (not even source C.) Therefore, if the evidence from source C can be transmitted into any other source to promote indirect-use, transmitting the evidence into STGs (source D) offers a unique advantage.

5. Other compelling characteristics of evidence that encourage use:
Similar to weakness in the evidence that has a tendency to decrease usage, compelling characteristics associated with evidence has a tendency to increase it. In addition to the above major tendencies, interviewees have identified compelling characteristics associated with all four types of sources. They identified evidence from sources A and B as 'reliable' since they have experienced them directly or indirectly. Evidence from C sources were acknowledged as 'rigorous' and that from source D as 'tested', 'well-structured', 'clear about what evidence it is based on, 'provide reference of where to look' and 'evidence that provides advantages of standardisation'.

6. Practitioners tend to search evidence from different sources to add more value:
The above tendencies are related to the nature of evidence and its sources. The rationale behind evidence use revealed the existence of organisational related tendencies. Several interviewees acknowledged that they peruse evidence from every possible source to increase the value of their work to clients. Some of them also regarded maintaining a strong evidence base internally to be a competitive advantage that makes them 'an organisation of choice' by clients.

In summary, these results reveal that there is no single evidence source that contains supreme tendencies to encourage their specific usage: all four types possess tendencies towards use and non-use. However, have unique tendencies that do not

exist in other sources. For instance, the tendency of ‘rigorous’ has been identified as the only tendency with competitive advantage , with source C identified as ‘rigorous’, whilst only evidence in source D was considered as 'legally enforced'. These unique tendencies can provide competitive advantage. Standards, Guidance and Tools (source D sources) have more positive tendencies than any of the other type, although, possessing such tendencies does not necessarily mean that Standards, Guidance and Tools will always be used.

As stated earlier, existence of tendencies does not guarantee the use of evidence from a particular source. The use or none-use may suffer or flourish or be suffocated by contingent conditions. The following contingent conditions (see Table 2) were identified through interview data analysis. '*' denotes that the particular condition has an impact on the designated evidence source.

Table 2: Contingent conditions

Condition	Source A	Source B	Source C	Source D
1. Availability of evidence	*			
2. Time and cost resources to access		*	*	*
3. Preferences for active knowledge over passive knowledge		*	*	*
4. Local contextual restrictions , project unique nature		*	*	*

Firstly, even though all four types of evidence have tendencies that influence the use of those sources, availability of evidence controls the use or none-use. This was identified as a key barrier for evidence in source A. When the design team acquires a new project that is unfamiliar, they do not possess sufficient internal evidence to cope. In other cases the internal evidence base was identified as 'not large enough' (a lower number of similar projects that the design team has previously undertaken) to obtain firm conclusions. These reasons determine the need to seek evidence from other sources. Secondly, time and cost resources have an impact on seeking evidence from external sources (B, C and D). This is a significant issue for source C, since evidences are scattered in a number of journals and the time and cost to access them creates a large burden on the project. An instance for attracting use of source C evidence occurs when these two barriers are not prominent. When healthcare clients have access to a great number of journals for medical purposes, they also search for therapeutic building evidence when they are involved in a building development project. This creates a flow of evidence from source C into the design process. Similarly, the need to pay for standards and guidance has been s a barrier for D sources. Thirdly, lack of faith in current knowledge transfer mechanisms has been a barrier to the use of external knowledge. Some interviewees expressed a preference for using the research evidence (source C) and guidance (source D) that are produced in conjunction with them. This suggests the importance of collaboration between academic institutions, those who produce standards, guidance and tools and practitioners. Finally, local contextual issues can also prevented use of evidence from external sources, even the use of mandatory evidence in source D. These are primarily site related and service/care model related issues, such as shape of available land, local building regulations, type of patients treated in the facility. For project unique issues project teams are obliged to devise solutions based on knowledge and experience.

These research findings are part of an early stage of abductive analysis that was used in the CR method. The next step is to postulate middle range theories (from the

identified tendencies) that could explain empirical level practices and then validate them with further rounds of data collection in a comprehensive abductive process. During these early steps, the researcher's experience was that postulating middle range theoretical level mechanisms for social science researches is easier than in natural sciences as claimed by Sayer (1992). For instance, from this analysis it could be hypothesised that some procurement arrangements have mechanisms that encourage better use of evidence. Similarly, different forms of evidence have different mechanisms encouraging the same. Yet, completing the whole research process needs either more time or involving more resources. Further, differentiating between causes that lead to mechanisms and contingent conditions was complicated and required critical thinking. This is due to some contingent conditions for the phenomenon concerned in this research could be a mechanism for some other phenomenon.

CONCLUSIONS

Previous researchers have identified barriers to transmitting research evidence (source C) into actual practice and in not taking a holistic approach. This research contributes to this gap by identifying the rationale for using various design knowledge sources during the design stage. Since all four sources contain inherent weaknesses, single forms of evidence source do not dominate evidence flows. Improving the rigour of evidence contained in all four evidence sources is therefore important to increase the practice of EBD. The rigour of the evidence provides a competitive advantage for source C, so removing the blocking contingent conditions should increase its application. However, its inherent weakness would still limit usage and it is hard to imagine a radical change that would resolve this, as Cama (2009) suggests, improvement will evolve with time. Standards, guidance and tools (source D) have many compelling characteristics that tend to increase the evidence contained within them. So their discontinuation, as recently contemplated due to changes in healthcare provision in England, is not appropriate and this was made explicit throughout the interviews. Lack of literature explaining the data analysis process for deriving mechanisms and continent conditions from data make it difficult for novice researches to apply CR.

The step in the research will be to conduct three case studies to identify the practice of EBD in depth and explore opportunities to improve it. A framework guiding how to improve EBD at project level will be subsequently derived.

ACKNOWLEDGEMENT

The research reported in this paper was funded by ESPRC IMCRC (EP/E002323/1) and EPSRC HaCIRIC core grants (EP/D039614/1 and EP/I029788/1). The authors wish to acknowledge the industry partners who participated in the interviews.

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