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Beyond an 'informed opinion': evidence-based practice in the built environment

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ABSTRACT

This study examines the sources of evidence that influence decision-makers who design or develop office buildings, and aims to explain why some managers engage more in evidence-based practice (EBP) than others. A mixed methods approach is conducted that combines quantitative results from 187 senior managers in the built environment and qualitative data from 18 interviewees. The respondents evaluated the use and trustworthiness of different sources of evidence, followed by an assessment of practitioners' adoption and understanding of EBP. This study discovers notable differences between how practitioners and academics view EBP. The results highlight the importance of a manager's learning goal orientation, the cultural norms of the work environment, and the industry-wide barriers for EBP. Implications for the adoption of EBP in the built environment at the individual, organisational, and industry levels are put forward.

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Introduction

The design and development of high performing buildings are more critical than ever before. Urban population growth is expected to result in an additional one billion people living in cities by 2050 (United Nations, 2017b). This growth, changing socio-demographics, and the need to improve living and working conditions, will require the doubling of global built floor area between 2015 and 2050. Given that buildings are currently responsible for 39% of global energy-related carbon dioxide emissions (United Nations, 2017a), this presents a pivotal point; the buildings required to support such growth can either increasingly strain our environment or apply best practices to achieve a two-to-tenfold carbon footprint reduction (Lucon et al., 2014). Yet, our buildings need to do much more than achieve low carbon performance. They need to provide thermal, visual and acoustic comfort and create an indoor environmental quality that enhances occupant satisfaction, health and productivity (Roulet et al., 2006). They need to be more socially sustainable by creating spaces for community interaction, rest and recuperation in cities (Hadi, Heath, & Oldfield, 2018). The design teams need to achieve all of this while making optimal decisions based on life cycle costs for the best future operation of building assets (Goh & Sun, 2016; Shi, Yan, Zuo, & Yu, 2016). This means that managers overseeing the creation of these buildings need to navigate their way through a wide array of competing evidence related to a complex multitude of economic, social, and environmental needs (Salama, 2008).

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How are decision-makers in the built environment currently guiding their decisions in the face of such complexity? There are numerous intricacies and challenges present in the decision-making process – involving a wide range of stakeholders, with a variety of priorities, and a myriad of factors involving design, costs, timings, and personal agendas. Previous research has highlighted the impact and complexity of decisions in the built environment, encouraging the use of Building Information Modelling (BIM) (Sacks, Eastman, Lee, & Teicholz, 2018) and other decision-making tools and practices to assist in the consideration of multiple data sources and goals (e.g. Caixeta & Fabricio, 2013; Jensen & Maslesa, 2015; Kamari, Corrao, & Kirkegaard, 2017; Petrova, Pauwels, Svidt, & Jensen, 2018). However, research to date has scarcely examined the extent to which different sources of evidence influence decision-makers in the built environment, and more importantly, the process through which the best available evidence is integrated into the decision-making process. The successful application of evidence to inform the optimal design of buildings has a huge potential, but should not be taken for granted (Petrova et al., 2018).

A particular criticism in the built environment is the lack of common and accessible feedback loops regarding evidence drawn from realised projects. In the original Royal Institute of British Architects (*RIBA) Plan of Work*, developed in the UK in 1962, the process of designing and realising a building was developed across several stages, from A to M (A: Inception, B: Feasibility, C: Outline Proposals, D: Scheme Design, E: Details Design, F: Production of Information, G: Bills of Quantities, H: Tender Action, J: Project Planning, K: Operations on Site, L: Completion, M: Feedback). Stage M was proposed to ensure the design team gathered feedback on how well the project met the client's requirements, in order to learn lessons for future engagements. Yet, Stage M was rarely taken up, with design teams seemingly unable to record collective experiences of feedback from users (Duffy, 2012). In the latest RIBA Plan of Work (RIBA, 2013), 'Stage 7: In Use' resurrects these initial ideas, promoting post-occupancy evaluation and a review of project performance. However, such activities are still rare, and even when undertaken, they often remain publicly inaccessible.

A lack of feedback loops in the built environment has led to a gap between predicted and actual measured building performance. For example, there is a well-documented gap in energy performance between pre-design simulations and completed buildings. One of the root causes, it is suggested, is a lack of appropriate assumptions by the design team, fuelled by limited data, knowledge and experience of climate and occupant behaviour (Zou, Xu, Sanjayan, & Wang, 2018). In addition, while academic research is undertaken to improve building performance across multiple fields and provide evidence supporting the positive effects of specific design features (see Clements-Croome, 2005; Ulrich et al., 2010), there exists a lack of knowledge transfer between academia and practice (Heylighen, 2008; Van De Ven & Johnson, 2006). In response, there have been calls to foster greater knowledge transfer between the two realms through collaborative research, and dissemination of findings in more accessible ways for industry (Bansal, Bertels, Ewart, MacConnachie, & O'Brien, 2012; Hall, Oldfield, Mullins, Pollard, & Criado-Perez, 2017).

In the health industry, some of these problems have been tackled through an evidenced-based practice (EBP) approach to hospital design. EBP refers to a decision-making framework that builds on the conscientious, explicit, and judicious use of the best available evidence from research and practice. EBP therefore involves collecting the available evidence from multiple sources, critically evaluating it, applying it to their specific context, and assessing outcomes (Briner, Denyer, & Rousseau, 2009). This shift to EBP was fuelled by healthcare design clients expressing interest in evidence that informs how the built environment would impact patient safety and returns on investment. This has resulted in design teams engaging with an EBP approach in healthcare design, including the rigorous gathering of research data from multiple sources, using evidence in decision making, hypothesising and testing relationships, and critically evaluating and sharing results (Zborowsky & Bunker-Hellmich, 2010).

Similar possibilities exist to engage with EBP across the built environment sector, with office design at the forefront. The design of office buildings in Australia are shaped by existing building codes, that provide guidance and minimum standards across multiple fields, including safety,

structure and energy performance. However, many office clients seek to provide performance far in advance of minimum standards, fuelled by a competitive market for tenants. The sector is a global leader in setting ambitious targets. For example, a number of Australia's leading property trusts are committed to being carbon neutral by 2030 across their property portfolios (Green Building Council Australia, 2018).

Like with healthcare facilities, there is an increasing awareness that office design can have a significant impact on the health, well-being and productivity of occupants, as captured in reports such as the World Green Building Council's *Health, Wellbeing and Productivity in Offices: The Next Chapter for Green Building* (WGBC, 2014) and the Commission for Architecture and Built Environment's *The Impact of Office Design on Business Performance* (CABE, 2005). Given the potential EBP provides to the field, this study examines the sources of evidence that influence the decision-making process during the inception and design of office buildings in Australia. Additionally, we determine the extent to which EBP is employed in the built environment and the factors associated with its practice.

To enable a comprehensive understanding of how EBP is undertaken by managers, a mixed methods approach is adopted for this study. The quantitative study measures the use of different sources of evidence among 187 senior managers in the built environment, and draws on the academic literature in organisational behaviour and psychology, namely learning goal orientation (Dweck & Leggett, 1988) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991, 2012) to develop and test a model of antecedents of EBP. The qualitative study broadens and deepens our understanding of whether EBP is adopted and the key factors leading to its practice by inductively drawing on the perspectives of built environment professionals.

In summary, this study aims to answer the three following questions:

(1) What sources of evidence are used and trusted in the built environment industry in Australia?
(2) How is EBP understood and practiced in the built environment industry?
(3) What drives the adoption of EBP in the built environment industry?

Background

EBP, also referred to as evidence-based decision-making, has grown into an interdisciplinary movement that calls for greater scientific underpinnings in professional practice (Briner & Rousseau, 2011; Hjørland, 2011). The origins of EBP can be traced to the field of medicine, where Sackett, Rosenberg, Gray, Haynes, and Richardson (1996) coined the term evidence-based medicine to refer to 'integrating individual clinical expertise with the best available external clinical evidence from systematic research' (p. 71). EBP has gained widespread acceptance in medicine (Claridge & Fabian, 2005; Kohn, Berta, Langley, & Davis, 2011), and the call for EBP has spread to other fields, notably education, policy making, and more recently management (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010; Rousseau & McCarthy, 2007; Simmons, 2015).

The cross disciplinary nature of management suggests that the principles of EBP can be useful to the built environment. Barends, Rousseau, and Briner (2014) describe EBP in a management context, underscoring the importance of drawing on the best available evidence from managers' expertise, organisational data, research findings, and stakeholders. The authors argue that by consulting with these four sources, critically evaluating the acquired evidence, and applying it to their specific context, decision makers can improve the probability of the desired outcomes. The built environment currently draws on these different sources of evidence, though it is unclear to what extent.

Much of the work on EBP in the field of management focuses on conceptual models and normative suggestions for the industry to utilise insights from academic research; there is little in the way of empirical studies (Barends et al., 2017). As a result, there is limited understanding of practitioners' grasp of this term, what enables or restrains EBP in the field, and the key drivers that may facilitate its adoption specifically in the built environment.

Why some managers engage in more EBP than others

EBP calls for a curious and critical mindset, questioning one's assumptions and building expertise through the collection of evidence from numerous sources. In recent decades, research and theory have emphasised the importance of motivational characteristics in predicting such behaviours. More specifically, an individual's learning goal orientation, which refers to an individual's disposition towards developing their abilities in achievement situations (Button, Mathieu, & Zajac, 1996; Dweck & Leggett, 1988), predicts variation in task interpretation, motivation and behaviour (Grant & Dweck, 2003; VandeWalle, 2003).

Learning goal orientation is among the most frequently studied approaches to motivation in psychology (DeShon & Gillespie, 2005). As a result, there is a large body of evidence supporting the impact of learning goal orientation on many employee-relevant outcomes (see the meta-analysis from Payne, Youngcourt, & Beaubien, 2007). Those who have a high learning goal orientation tend to believe that their attributes and skills can be developed (Dweck, 1986), and are therefore inclined to view effort as a path towards mastery and success in their careers. Hence, these individuals are more likely to value and select learning tasks, as well as seek feedback for continuous improvement (DeShon & Gillespie, 2005; Elliott & Dweck, 1988; Payne et al., 2007). The consequences of learning goal orientation regarding an individual's motivation and behaviour suggest that it might be a key factor influencing the adoption of EBP in the built environment context. To better understand this, the mechanisms through which learning goal orientation might influence EBP are next reviewed with the aim of proposing a conceptual model that considers individual and contextual factors relevant to the built environment.

Towards a conceptual model of EBP

The process of how learning goal orientation impacts behaviour was proposed and tested by van Hooft and Noordzij (2009). The authors used Ajzen's (1991) TPB as a conceptual model to argue that goal orientation impacts an individual's intention to engage in a behaviour, their subsequent actions, and their performance for a given behaviour. However, van Hooft and Noordzij (2009) did not examine the overlap between learning goal orientation and TPB, and their joint predictive power. Given the collective nature of many of the decisions in the built environment, it is essential to consider the context in which the decision is being made as well as individual dispositions such as learning goal orientation. Therefore, we propose a research model that includes Ajzen's (1991) TPB. TPB contends that any given behaviour is determined both by an individual's intention and the perceived barriers within their context. TPB incorporates individual factors – (1) the attitude towards its practice, and (2) the perceived capability to perform it – as well as contextual factors via inclusion of social norms about a given behaviour.

A large body of evidence in support of the TPB has emerged across many different contexts. Meta-analyses such as Armitage and Conner's (2001) and McEachan, Conner, Taylor, and Lawton's (2011) have confirmed the predictive validity of the model. Many of the applications of TPB concern health related behaviours (Ajzen, 2011). However, the model has also been used to explain behaviours in work environments, such as IT usage and technology adoption (e.g. Francis et al., 2008; Hung, Ku, & Chien, 2012; Venkatesh & Davis, 2000), entrepreneurial behaviour (e.g. Carr & Sequeira, 2007; Kautonen, Luoto, & Tornikoski, 2010; Kolvereid, 1996), and more recently, the decision-making of interior designers (Lee, Allen, & Kim, 2013).

By drawing on learning goal orientation from van Hooft and Noordzij (2009) and TPB (Ajzen, 1991, 2012), a research model for EBP is proposed whereby learning goal orientation and TPB explain unique variance in EBP, but also overlap in explaining attitude toward EBP, intentions to adopt it, and adoption of EBP (Figure 1).

The research model presented above is applied to the context of practicing EBP during the design and development of high-performing office buildings. EBP involves questioning the established beliefs by unpacking different facts and scenarios, therefore generating and applying novel solutions

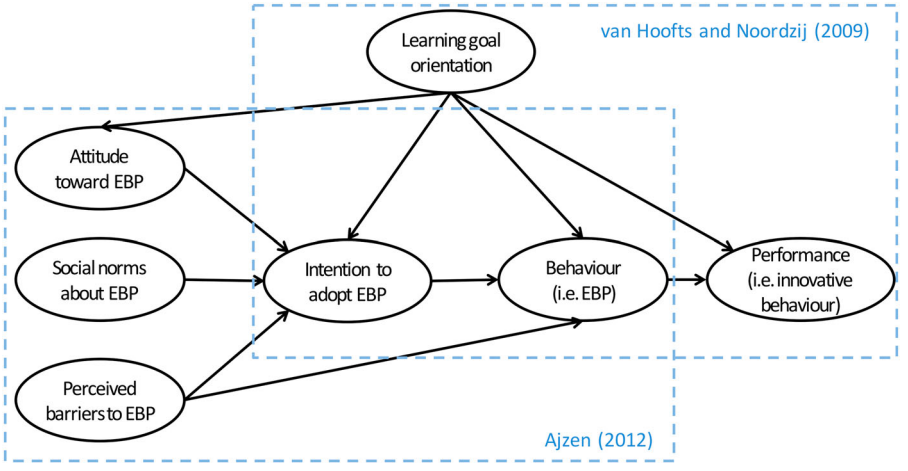

Figure 1. Proposed model of EBP including antecedents and consequences.

to problems. Hence, innovative behaviour is an expected performance outcome of EBP and increasingly relevant in the built environment because of the many novel technological and design solutions for high-performance buildings (Kraatz & Hampson, 2013; Newton, 2013). Thus, we measure 'performance' with an individual's innovative behaviour.

Methods

The epistemological stance taken in this study is mostly aligned with that of critical realism, which acknowledges that all methods have limits and emphasises the benefits of combining different forms of data (Rousseau, Manning, & Denyer, 2008; Van de Ven, 2007). Therefore, the validity and completeness of this study was enhanced by adopting a mixed methods approach consisting of an online survey followed by interviews. A survey is best suited to collect data from a large sample, permitting the examination of relations proposed in the EBP process model through structural equation modelling (SEM). SEM investigates causal relationships among latent constructs. This technique involves a family of related procedures combining multiple regression and factor analysis, yielding the degree to which the hypothesised effects and overall model are supported by the data (Kline, 2016). On the other hand, semi-structured interviews provide depth in interpreting the statistical results (Ivankova, Creswell, & Stick, 2006). To focus on managers who influence decision-making, the survey was restricted to those holding a senior management position (i.e. CEOs, directors, principals and senior managers) and currently involved in the inception, design or development of office buildings in Australia. Participants were selected from three industry partners in the built environment, and extended to their external networks. Additionally, individuals who matched the selection criteria from specialised groups such as alumni from Built Environment faculty were also invited to participate.

Survey measures

The survey consisted of established measures (see below) that were collaboratively adapted for the built environment industry with a focus group of built environment professionals. A total of 203 participants completed the survey. However, 16 participants were dropped from the sample as they reported not being directly involved in the decision-making process under study. Out of the 86% of participants who reported their gender, 29% were female and 71% were male. The average tenure in their field was 18 years, and their mean age fell within the 40–49-year-old range. Further details regarding the scales used to measure each of the constructs in Figure 1 are provided next.

The extent to which participants relied on different sources of evidence, and the level of trustworthiness of those sources were adapted from Barends, Villenueve, Briner, and ten Have (2015).

TPB variables were measured through scales that have been extensively used and validated in previous studies (e.g. Armitage, Conner, Loach, & Willetts, 2010; Arvola et al., 2008). For attitude toward EBP participants responded to the question 'I think that practicing evidence-based decision-making in the context of my work environment is' on a five-item: bad/good, foolish/wise, harmful/beneficial, unsatisfying/satisfying, not useful/useful. Perceived barriers to EBP measured participants' perceived capability to practice EBP in their context. This was measured with a three-item scale. A sample item is 'If I wanted to I could easily engage in evidence-based decision-making at work'. Social norms about EBP were measured using a three-item scale. A sample item is 'In my workplace, most people who are important to me think that I should engage in evidence-based decision-making'. Intention to adopt EBP was measured using a three-item scale. A sample item is 'I intend to practice evidence-based decision-making in the future'. EBP was measured by asking each respondent to assess his or her own engagement in EBP through a ten-item scale included in Appendix A.

Learning goal orientation (Vandewalle, 1997) was measured using a five-item scale. Sample items include 'I often look for opportunities to develop new skills and knowledge' and 'For me, development of my skills and knowledge is important enough to take risks'. Innovative behaviour was measured using a five-item scale adapted from De Jong and Den Hartog (2005). This scale measured the extent to which the participants generate, promote and implement innovative ways of working. Sample items include 'I come up with creative solutions for problems' and 'I promote and defend innovative ideas to others'.

Control variables. The following demographic data were also measured as control variables: gender, age, education, years of experience in their field, employer, job position, and area of influence regarding the building's creation.

Interviews

A total of 18 professionals who responded to the survey were interviewed with the aim of gaining a more in-depth understanding of the survey results. The interviews were semi-structured and guided by the interview protocol (see Appendix B) which includes questions related to two categories: (a) How EBP is perceived and practiced by major decision-makers in the built environment sector; (b) Relevant factors impacting the adoption of EBP in the context of the built environment. To interview diverse stakeholders within our target sample interviewees were selected based on two criteria. Firstly, the survey responses were used to rank respondents based on the extent to which they reported adopting EBP. Those respondents at the top and bottom 10% of the list were prioritised to mitigate the risk of selection bias. Secondly, managers from different organisations and professions were interviewed as the research questions sought to generalise insights about EBP across the built environment industry. The 18 interviewees worked for 10 different organisations including architects (5), engineers (4), consultants (2), interior designers (2), project managers (4) and a building developer (1). All participants were senior managers (e.g. managing directors, senior associates, senior consultants), who confirmed their experience in the field and having a significant influence on the decision-making under study. The majority of the interviewees were male (13 out of 18) and were located in Sydney (13), Melbourne (3), and Brisbane (2). The duration of each interview varied from 45 to 90 min, depending on the interviewees' availability and the depth of their responses. All interviews were audio recorded and transcribed.

The first phase of data analysis involved open coding. Open coding is 'the analytic process through which concepts are identified and their properties and dimensions are discovered in data' (Strauss & Corbin, 1998, p. 101). This process helped identify how the interviewees conceptualised EBP, and the factors impacting their decision-making processes. This exercise was inductive in nature and allowed

for the discovery of patterns and themes in the data which led to the initial codes and first-order categories. In the second phase of data analysis, the data were analysed by searching for relationships between the first order categories while identifying a larger narrative related to the research questions (Gioia, Corley, & Hamilton, 2013).

Results

What sources of evidence are driving decisions in the built environment industry in Australia?

As part of the quantitative study, the sources of evidence used by built environment professionals were explored, both the extent to which various sources were used, and also the trustworthiness of these sources. Figures 2 and 3 present the results.

Feedback from previous projects is the source of evidence that senior managers report to be using ($M = 4.12$, SD = 0.67, on a 5-point scale) and trusting ($M = 4.44$, SD = 0.64, on a 5-point scale) the most. Recall that the built environment literature pinpointed that a feedback loop to gather and analyse evidence is generally lacking. However, this data suggested that this challenge seems to currently be less prevalent in office building design and development in Australia. Furthermore, consultants' insights and colleagues' advice also appear to influence decision makers to a large extent. An interesting insight is the relatively low use and trustworthiness of academics' insights (reported use: $M = 2.66$, SD = 0.93, on a 5-point scale), and the difference in responses regarding up-to-date research findings' ($M = 3.30$, SD = 1.07, on a 5-point scale). Research findings, which are provided in various formats by industry bodies, consultants, or the firms themselves through pilot testing and simulations, are seen in a positive light. This contrasts with the use and trustworthiness of insights provided by academics. Overall, this data suggest that decision-makers are relying heavily on feedback from previous projects, and also considering other sources of evidence. Furthermore, the use of academic research is used less often and not considered to be much more trustworthy than their own intuition.

The interviews provide qualitative data that deepen these insights about the use and trustworthiness of different sources of evidence. When the interviewees were asked about the sources of evidence that informed their decision-making, they referred to expertise within their organisation, consultants' advice, and learnings from previous projects. However, an important nuance was that feedback collected from customers was often anecdotal evidence from the tenants making it

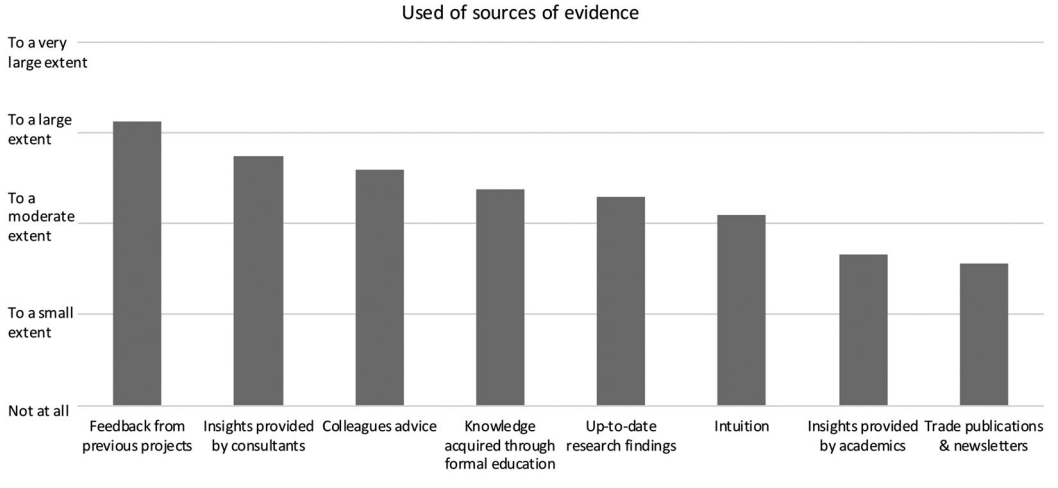

Figure 2. Used sources of evidence.

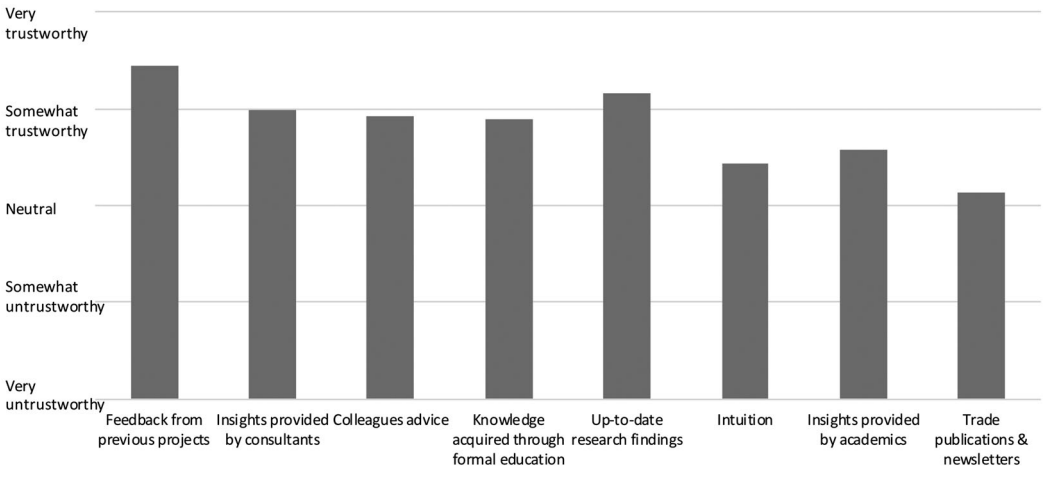

Figure 3. Trustworthiness of sources of evidence ranked in frequency of use.

difficult to gain any insights regarding the building's operation and impact on the occupants and wider society:

> … it's not really scientifically rigorous, it's basically an organisation that goes back to several projects where they've been working … they interview the facility managers to see how happy they are with it.
>
> (engineer)
>
> We do make 3 month, 6 month, 12 month phone calls to our clients [developers], but I think we would be better off doing a deeper study that actually asks the occupants of the building what they think.
>
> (architect)
>
> I don't think there's enough data around on how people feel, you know, the indoor environment quality or the tenant satisfaction data. That would be really useful … but we don't really have that data. There's not a database of that.
>
> (consultant)

Participants also highlighted the use of research findings, referring to data collected by themselves or by industry bodies within the built environment. However, when asked about the use of academic research participants responded that it is not commonly consulted as it is considered less trustworthy and relevant. Besides voicing their frustration in not knowing where to find relevant academic research, several interviewees from different professions labelled it as incomprehensible or outdated:

> A lot of material is produced, research is produced, it's practically incomprehensible because it's so dense.
>
> (architect)
>
> There's a perception that [academic research] is not as relevant … Sometimes the market is moving very quickly and some of the research might not be as relevant because it's taken time to get to market.
>
> (engineer)

These results are aligned with the growing distrust in academia and scientific research highlighted in the EBP literature (Rynes, Colbert, & O'Boyle, 2018), and calls for urgent action on behalf of academics to address this issue by working closer with practitioners (Bansal et al., 2012), focusing on issues that are important to industry (Bennis & O'Toole, 2005), and improving the research dissemination methods (Huber, 2018; Rynes et al., 2018).

How is EBP understood and practiced in the built environment in Australia?

When asked about EBP in their work environment, survey respondents reported a positive attitude towards its practice ($M = 4.43$, $SD = 0.82$, on a 5-point scale) and moderately high adoption ($M = 3.10$, $SD = 1.37$, on a 5-point scale), suggesting that managers are engaging in EBP. It may seem paradoxical that managers are reporting high levels of EBP while acknowledging that evidence from academic research is mostly ignored. Therefore, the understanding and perceived use of EBP was explored through the collection of qualitative data. The data analysis resulted in first order categories grouped into two themes that provide a better understanding of the perception and use of EBP: prudent practice, and constrained exploration.

The first theme, prudent practice, is comprised of the following first order codes: use of standards and codes; ratings shaping the design; repeating approaches from previous projects; consulting with experts; and benchmarking. Overall, this theme depicts the numerous sources of evidence that are used in line with EBP, and also illustrates what is considered by the participants to epitomise EBP in the built environment context. When asked about EBP, interviewees often referred to the important role of standards and codes that they must adhere to, and the role of rating schemes in driving decisions given their importance for customers. The fact of having previously applied a particular process or design to support its selection was repeatedly reported as the most persuasive piece of evidence to decision-makers and a fundamental aspect of what interviewees consider to be EBP. As an example, when asked about what is considered strong evidence within their context, a senior manager responded:

> For our industry, evidence is that we've delivered it before and it works
>
> (project manager)

The qualitative data confirms that decision-makers are drawing on multiple sources, and that EBP is perceived as important and fairly common in the built environment. However, the second theme that emerged from the data labelled constrained exploration suggests major shortcomings and disparities between the professionals' practice of EBP and the definition in academic literature. The first order categories comprising this theme are: considering academic work irrelevant; seeing evidence as constraining; lacking awareness that more evidence enables self-improvement; relying heavily on intuition and heuristics; and cherry-picking evidence to support a previously made decision.

The sources of evidence feeding into a decision that is considered evidence-based by practitioners falls short compared to the academic definition. Most participants see EBP as the concept of basing their decisions on the relevant standards and industry codes or on their experiential evidence. EBP involves making decisions based on the best available evidence from practice and research. As the following quote illustrates, practitioners in the built environment only require the former to consider that EBP is adopted:

> I think in the work that I'm involved in, it's [EBP] probably related to where we say we have a client group, we have built up a particular knowledge about key issues over a period of time, and they would document those experiences to influence decisions on future projects.
>
> (architect)

In doing so, potentially relevant evidence is neglected. As described above, academic research is often ignored, and as the following quotes illustrate, there can be a disregard to continuously improve by building on the available knowledge:

> So we start ever job anew, and we reinvent the process to get to the end every time … I think the nature of the industry is that it's not inclined, psychologically, to be quite rigorous in gathering data and analysing.
>
> (architect)

> What is the blocking jinx? It's almost the self-awareness that you actually need to do it [collect evidence] to get to self-improvement.
>
> (architect)

The data also indicate that EBP is sometimes implemented for a different purpose than initially conceived. EBP involves seeking and appraising evidence to inform a decision. In contrast, several participants highlighted that its adoption runs the risk of decision-makers 'cherry picking' evidence to support their opinions, or to legitimize a previously made decision. Such an exercise could be labelled 'decision-based evidencing', turning the process on its head and failing to improve decisions. The following quotes illustrate this practice.

> I've had my experience in my work environment that there are those who almost construct their research to support the answer they are searching for.
>
> (architect)

> Interviewee (architect): That's what we're doing with all of the evidence too. We're pulling out the relevant parts in order to try and influence them to take what we believe to be the preferred design approach.
>
> Interviewer: Interesting. You're collecting evidence to support your already formed proposal or opinion?
>
> Interviewee (architect): Quite often.

In brief, the interviews helped clarify how the term EBP is understood by some practitioners in the built environment and shed light on the ways in which its practice is adapted or misused in their context. Perhaps the most notable differences between the academic understanding of EBP and the participants' interpretation of the term involves the different expectations regarding the amount of evidence collected, and the value of scientific knowledge alongside the personal experience.

What drives the adoption of EBP in the built environment industry?

The proposed model to predict EBP helps understand why differences in EBP adoption exist in the built environment. The model was tested in MPlus 7.31 by conducting a SEM. This resulted in good model fit: χ^2 (512) = 790.04, $p < 0.001$; Comparative fit index = 0.91; Root mean square error of approximation = 0.05; A value of χ^2 divided by the degrees of freedom below three demonstrates reasonable fit (Kline, 2004). Additionally, the absolute fit indices such as the root mean square error of approximation indicate a close fit with values of 0.05 or less (Browne & Cudeck, 1992). Given the satisfactory results, we can interpret the significant pathways in Figure 4 below.

Overall, these results support the proposed model; the model is a good fit with the data, and theoretically expected relationships are significant with the exception of the relation between perceived barriers to EBP and intention to adopt EBP. More broadly, this model explains what predicts actual use of EBP. In accordance with the TPB, our results show that EBP is directly predicted both by intentions to use EBP and perceived barriers. Notably, learning goal orientation is an important individual factor associated with EBP ($\beta = 0.29$, $p < 0.01$), explaining the additional variance of EBP above and beyond that explained by TPB. Both EBP and learning goal orientation are positively associated with innovative behaviour. These findings suggest that learning goal orientation will also impact the extent to which managers define and apply innovative solutions, partly through the effective application of EBP.

Among the predictors of intention to adopt EBP, social norms have a strong impact on intention ($\beta = 0.35$, $p < 0.01$). This indicates that the working context and the subsequent cultural norms from the built environment have a significant effect on EBP adoption. This finding was further explored with qualitative data by focusing on the practitioners' understanding of their work environment and the norms that shape the use of EBP. When asking the interviewees to describe the decision-

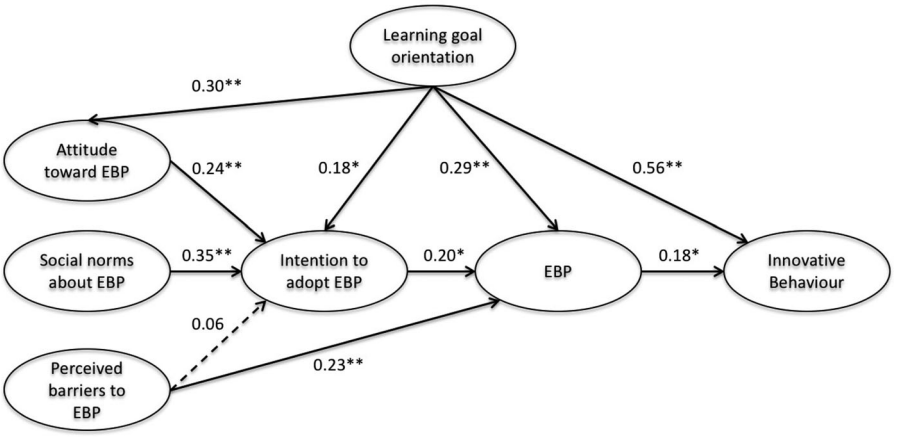

Figure 4. Process model of EBP. Significance levels: *$p < .05$; **$p < .01$

making process for the creation of a building, it emerged that there was a norm amongst professionals in the built environment industry to focus on mitigating risks and reduce uncertainty. As one interviewee briefly put it, *You're trying to avoid risk. You're trying to avoid failure*.

Decision-making regarding the design and construction of buildings is characterised by a complex environment. There are often numerous stakeholders debating a large number of elements that interact with each other. Given the high stakes and the level of complexity, it is no surprise that professionals in this industry work conservatively to mitigate risk. As explained by an architect and a consultant below, managers in this environment face this issue by simplifying the decision-making process through the use of standards, ratings and well-known concepts from previous projects.

> We tend to, in the building industry, stick to codes, rules of thumb, and what the guy next to me did last week on the other project.
>
> (architect)
>
> I think in the building industry, there's a large extent to which, over time, things become this is the way it's been done in the past, and no one's been sued, therefore we'll stick to this.
>
> (consultant)

Furthermore, this behaviour is perceived as a common practice and an expectation of how it should be done, establishing an industry-wide norm that is heavily influencing the decision-making process and the evidence that is considered. As a result, when searching for evidence time is scarce and the scope is limited to the few channels that the industry norms deem legitimate and reliable, such as guidelines provided by rating schemes, consultants, and the accumulated expertise within their organisations. The first order categories that emerged as impacting EBP were: risk averse environment; covering my back; lacking time; and constrained sharing of information.

In summary, in addition to individual and organisational factors associated with EBP, the findings highlight that EBP is also impacted by wider social norms in the industry. The data suggest that the decision-makers operate in a risk averse environment, and as a result, the norms are reinforcing each stakeholder to adhere to an established routine. The routines driving the collective decision-making involved in the design and development of office buildings include relying heavily on previous experience, and rating scheme requirements. Unfortunately, these routines do not leave room for sharing and considering additional sources of evidence that could improve decision making through increasing the use of EBP.

Discussion and conclusions

This study aimed to shed light on the sources of evidence driving decisions in the built environment context in Australia. In doing so, we also aimed to examine how EBP is understood and practiced in the built environment, and to propose a process model that explains what drives the adoption of EBP in this context. This study provides important insights on how to optimise the design and development of high performing buildings through well informed decision-making.

Results suggest decision-makers are drawing on multiple sources of evidence, namely, experiential evidence, knowledge within the organisation, and consultants' advice are heavily used and trusted in guiding decision-making. Whereas, insights provided by academics are not considered as relevant, thus information from scientific research is often overlooked. Unpacking these results shed light on the dissonance between academics and practitioners when referring to EBP. While academics embrace the use of expertise, organisational data, and consultants' insights, scientific research is also considered a vital component for EBP. In contrast, managers in the built environment have a more flexible use of the term EBP, often referring to EBP as the process emerging from a combination of their personal experience or evidence gathered in the search to justify a decision, rather than using evidence to guide or adjust decisions. The over reliance on previous experience to inform current practice is a major constraint for innovation, which can be driven by questioning assumptions and applying new ideas emanating from research activities (Levinthal & March, 1998). This disconnect between academic research and practice highlights the need for closer collaboration and the use of channels other than academic journals to communicate research findings.

Widespread adoption of EBP, defined as the conscientious, judicious, and explicit use of the best available evidence from research and practice (Briner & Rousseau, 2011), may be a long way off in the built environment. The routines that drive managers' decisions seem to restrict the sources of evidence they consider, leading them to rely on and potentially overestimate the epistemic authority of well-established guidelines and experiential evidence, over more systematic knowledge. The standards to which managers must adhere and the guidelines that are influencing managers' decisions in the built environment are helpful tools to guide complex decision-making processes. Similarly, experience and intuition are immensely important to inform managers' decision-making. It is encouraging to see that the built environment industry is using these ranges of evidence as a feedback process. This indicates that the industry has taken on board the importance of feedback, as was outlined by the professional guidelines and literature in the introduction (e.g. CABE, 2005; RIBA, 2013).

However, in alignment with Rousseau (2012), we argue that in a knowledge-based era, being critical in searching for the best available evidence is an important compass for navigating towards accurate decision-making and away from cognitive biases, fads, and out-dated beliefs. The development of high performing buildings will particularly benefit from adopting EBP, as it will assist in accessing the best available evidence promptly and directly, to apply innovative solutions that perform above and beyond the standard practices set by buildings codes and standards. That is, we encourage the built environment industry to stretch further, so that the inception, design, and post occupancy feedback processes take on rigorously collected evidence from a broader range of sources, namely building occupants and academic research.

The findings from this study suggest that EBP can be encouraged in the built environment at the individual, organisational and sector levels. Focusing on the learning goal orientation of decision makers and the cultural norms regarding EBP within an organisation may help foster EBP. However, the adoption of EBP in the built environment sector is also dependent on industry-wide established routines and expectations that shape the decision-making process. In alignment with Heylighen (2008), the data depict a preference for practice-based knowledge. Unfortunately, established routines do not facilitate the adoption of EBP; they reinforce the use of experiential evidence, while hindering the collection, use and dissemination of evidence from a wider range of stakeholders and scientific research.

Lastly, this research is amongst the first to empirically predict EBP, and presents the foundations for a theoretically grounded model of EBP. The link between learning goal orientation and TPB is also

studied for the first time in this article, providing evidence of the conceptual overlap between learning goal orientation and TPB. This theoretical contribution benefits the literature by expanding the understanding of the mechanisms through which learning goal orientation influences an individual's beliefs and behaviour.

Limitations

This research presents an in-depth empirical study of the decision-making process among senior managers that is valuable both in the built environment and in the EBP literature. Nevertheless, the study has limitations. The sample was comprised of managers associated with the design and development of office buildings in Australia from diverse functional affiliations. Whether the findings also apply to the built environment sector in general, to other regions, and to other industries needs to be assessed in future research. Nevertheless, some of the findings align with the conclusions of studies on the uptake of research findings in several industries. For example, the detected lack of use of scientific research is aligned with previous research on architects (Heylighen, 2008) managers (Barends et al., 2017; Rynes, Colbert, & Brown, 2002) and educators (Hemsley-Brown & Sharp, 2007). Similarly, the positive attitude towards EBP found in this study is comparable to those found among samples of managers (Barends et al., 2017) and healthcare professionals (Ubbink, Guyatt, & Vermeulen, 2013). We expect that the general model we put forth (Figure 1) would generalise across different building types and samples of built environment professionals (e.g. different countries). However, the weight of each construct in predicting EBP may vary. We would expect differences when comparing the context of office buildings with projects involving residential or industrial facilities. It would be interesting future research to explore these differences and to test whether the model holds for EBP in other professions. Lastly, future research might provide further insights through multiple case studies, yielding contextually rich, practical examples on how decisions are made at different degrees of EBP and their corresponding outcomes.

Recommendations

> We would be a stronger smarter company if we were more organised and did more of it [EBP].
> (Managing director at an architecture firm)

Processing information and subsequent decision-making are arguably one of the most important activities that managers undertake in their organisations (Minjina, 2015). Previous research has highlighted the huge potential to improve the design by building on the data available from the existing building stock (Petrova et al., 2018). Indeed, in a knowledge-intensive era, the survival and competitive advantage of organisations calls for continuous learning and informed decision-making. In adopting EBP, decision-makers will draw on data from the existing building stock, and complement it with the best available evidence from within and beyond the built environment. More importantly, the need for EBP in the built environment is more critical than ever due to its increasing activities and the long-term impact that new building designs will have on the environment and their occupants' well-being.

The findings suggest that organisations could consider learning goal orientation during the selection process, particularly for management positions that have a strong influence on the decision-making process. Our findings show that individuals with a high learning goal orientation will tend to show a more positive attitude towards EBP, a stronger intention to adopt the framework, and a subsequent higher adoption of EBP when compared to a low learning goal orientation decision-maker.

Social norms emerged as an important influence for the adoption of EBP, highlighting the importance of a culture that embraces EBP. Managers who aim to increase the practice of EBP with their teams could explicitly encourage the actions that it entails, and ideally inform their colleagues about other projects where EBP principles were adopted. This study has also shed light on the

influence of norms that transcend the organisation, as established routines influence the extent to which EBP may be adopted in a given industry. Routines are useful in standardising a decision-making process and increase efficiency, but can do so at the expense of driving out the explorative activities within an organisation (Levinthal & March, 1998). The literature on organisational ambidexterity suggests that organisations are able to integrate explorative tasks within their routines to balance explorative and exploitative activities (Collins, Barbour, & Gibson, 2017), and therefore enable EBP.

In light of these findings, two final remarks are worth highlighting. First, we need to heed caution about researchers and managers using the term 'evidence-based' in the built environment as it can be interpreted in many ways. While some might be referring to a comprehensive search for evidence from multiple sources, with a serious effort to critically evaluate and apply it, others might have a much lower standard and will simply refer to a decision supported by anecdotal evidence. Second, consultants, policy makers, and industry bodies can play an important role in fostering EBP. The advice and guidelines provided by these stakeholders have a significant impact on decision-makers in the built environment. If these guidelines are based on the best available evidence, the practice of EBP would likely be enhanced. Encouraging further efforts from researchers, managers, and policy makers to build on each other's expertise is essential to foster EBP and deliver high-performance buildings that meet the environmental, economic and social challenges we face in the future.

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Appendices

Appendix A. Evidence based decision making scale

EBP was measured by adapting a scale from Jepsen and Rousseau (2016). The construct was measured by asking each respondent to assess his or her own adoption of EBP through a ten-item scale presented below. The coefficient H and Cronbach's alpha are .88.

Please indicate to what extent the following statements describe your decision-making practices (1 = not at all; 5 = to a very large extent).

(1) At my workplace I make decisions based on evidence
(2) I tend to use evidence when implementing a new way of doing things
(3) I tell my colleagues about the evidence for implementing a new way of doing things
(4) I ask for feedback after implementing a new way of doing things
(5) I involve my team in research on workplace issues
(6) I share with my team the information on the success (or otherwise) of a trial or a new way of working
(7) I evaluate the success of a new way of working
(8) I share experiences of workplace trials, changes, and new implementations with other managers
(9) I critically evaluate the quality of evidence I use when making decisions
(10) I rely on multiple sources of evidence when making a decision

Appendix B. Protocol for semi structured interviews

(1) Could you please describe to me the general roles and responsibilities of your current job?
(2) How do you influence the design of office buildings or workplaces?

How EBP is perceived and practiced by major decision makers in the built environment sector:

(1) If you think of a situation in which you were deciding on design characteristics of a building, could you briefly describe how these decisions were made?
(2) What are the main arguments that are used to support the different alternatives? Which ones convinced the team to select a particular option?
(3) What sources of evidence did you use to form an opinion?
(4) When decisions are made, is information about the outcome used in future decision-making?
(5) Would this scenario be different when making a general management decision, such as a team management decision or a strategic decision? How so?
(6) Before this study, had you ever heard the term evidence based decision-making before? Yes / no. If yes, what do you understand by this term?
(7) (Give definition for EBP). Would you say EBP is implemented in your work environment when making decisions regarding the development of a building?

Relevant factors impacting the adoption of EBP:

(1) You mentioned how EBP is/is not practiced in your work environment. What facilitates/hinders EBP?