LOW CARBON LIVING CRC

The Tenant's Role in Creating the Business Case for High Performance Low-Carbon Buildings: Systematic Literature Review and Post Occupancy Evaluation

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- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2007),

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Executive Summary

The ultimate test of the business case for high performance low carbon building is to consider how the human benefits of these buildings could be reliably quantified to prove beyond all doubt the positive Return on Investment (ROI). After all, staff costs, including salaries and benefits, typically account for about 90% of business operating costs. Therefore, what may appear a modest improvement in employee health or productivity can have a huge financial implication for employers – one that is many times larger than other financial savings associated with an efficiently designed and operated building. In this report, the researchers explore the potential of tenants/owners occupying high performance low carbon buildings to create positive environmental behaviours among the occupants so that the building should perform as it is.

The report is structured in two stages. In the first stage, a systematic review is conducted to explore the previous studies that support embedding organisational practices at an organisational or tenant level to incorporate effective occupants' performance in these buildings. Secondly, post occupancy evaluation surveys are developed and conducted at both employee and management levels, to examine the relationship between behaviours and performances in high performance low carbon buildings. Findings from this study explain how organisational practices can encourage behavioural change which indirectly influences the occupants both physically and psychologically, thus creating a socio-psychological culture to understand the sustainability needs of the buildings in a comprehensive way. The report does not deny that technical elements can improve productivity and wellbeing, but it does offer a perspective that involves a paradigm shift to use behavioural elements to enhance this process. The research findings outlined in this report sets the groundwork for businesses to begin to answer this tantalizing question as to the true payback for building green.

The key findings from the Systematic Review include:

- The tenant organisations are crucial in improving building's overall performance by influencing the occupants' performance
- This is possible by generating direct engagement through key organisational functions
- The immediate outputs will be critical in attracting the external pool and motivating internal occupants to be committed to the organisation.

The key findings from the Post Occupancy Review (POE) include:

- The key organisational practices by the tenants to improve performance depends on the attitudes of the occupants, resources available to them and social influence
- Tenants' can improve the occupants' environmental behaviour through organisational practices at a strategic and operational level

Introduction

Background

Traditionally, buildings consume a great amount of resources. In recent decades, the relevance of research into high performance low carbon buildings is concentrated in the areas of wellbeing and productivity (Heerwagen, 2000). While there is increasing attention paid to sustainable building techniques to maintain wellbeing and productivity, there has been relatively little discussion about understanding the behaviour of the occupants that can maintain the performance of such buildings. A comprehensive research agenda to embed socio-psychological aspects from academic as well as practitioner fields is still its formative stages. Occupants' benefits attributed to high performance low carbon building strategies include increased performance and productivity, increased environmental satisfaction, and positive impacts on both physiological and psychological health. Such buildings provide facilities and shelter from the elements to support human activities. They are designed to provide for human behaviour, including meeting psychological and social needs. Whether or not these measures are successful depends in large part on the degree to which designers accurately understand and predict what activities are required and likely to occur, and their ability to use this knowledge to create space and facilities to support their predictions (Wener and Carmalt, 2006). There are many positive aspects to high performance low carbon building including reduced energy use associated with tenants' benefits such as reducing operational costs (Von Paumgartten, 2003, Johnson, 2000); however, these may not be realized if occupants are not using the building as intended. In a high performance low carbon buildings, occupant behaviours and interactions are a key element in whether the building can negatively or positively affect energy outcome (Day and Gunderson, 2015). The impact of high performance low carbon building practices is significant for the management research. The involvement of management/tenants/owners can be the catalyst for drawing the potential connections between the performance of these buildings and overall organizational success. Industry players are increasingly implementing green building practices as a result of demand from the market consumers, investors, shareholders, employees, the community and government (GBCA, 2006). The benefits that can accrue to them include reduced infrastructure and plant and equipment costs, enhanced reputation or brand and reduced operational costs. However, there is a lack of consideration on how the tenants can improve performance in these buildings.

The relationship between office design and office users

Previous research clearly demonstrates that office design has an impact on the wellbeing and productivity of its occupants (Johnson, 2000, Heerwagen, 2000, Von Paumgartten, 2003). However, this evidence is not yet translating at scale into design and financing decisions since there are inter-related issues to be considered in understanding high performance low carbon buildings studies: people (owners, occupants), products (materials, structure, equipment, controls, services), processes (maintenance, performance, management). Existing post occupancy evaluation tools have considered much of the people and products categories, therefore limiting their ability to capture the process side including the wide range of behavioural, situational, and social–psychological measures that are known to influence how users experience buildings (Brown and Cole, 2009). It is a major challenge to synthesize data when a large number of social and psychological barriers are considered. Building features and attributes associated with strategic performance are likely to be a somewhat different set of factors than those associated with improved interior quality, although some overlap is inevitable (Heerwagen, 2000). There are many reasons why buildings do not perform as well as expected; however, the hardest-to-manage reason for longer-term performance gaps is the way people behave in their buildings. Individual occupants and the choices they make – such as opening or closing windows, overriding automated systems or leaving appliances on – directly affect the building's energy performance.

Environmental psychology informs us that individuals with positive environmental attitudes i.e. attitudes to behave in favour of the natural environment, are more likely to feel morally compelled to act in order to correct the negative consequences of human environment interaction with the design of the office. The academics and practitioners are gradually focussing on the need for environmental leaders to drive occupants' behaviour in high performance low carbon spaces when it comes to improving the performance of the buildings and the occupants. Senior managers' contribution are considered essential because they can create and foster conditions through their endorsement (Sawang and Kivits, 2014). However, while much research highlights the important role of management, stakeholders of these buildings may not see the responsibility of management in encouraging employees' performance aspects in high performance low carbon buildings as their concern. Therefore, although there has been some discussion within the sociological literature of the need to consider the physical environment, there do not appear to be any empirical studies exploring trends on how built environment research priorities of management to improve performance in high performance and low carbon buildings (Pfeffer, 1998). Given this lack of precedent, speculation on similarities and differences between the management and design/behaviour research streams will be based on two assumptions:

1. Researchers in the design field will tend to have a high concern for the physical environment that can also make the occupants comfortable.

2. Management researchers will tend to focus on aspects of the physical environment that can be linked most directly with organizational processes or outcomes.

Aims

One of the key barriers to incorporating considerations of building impacts on occupants into business decisions has been confusion around what to measure; and how to measure the effects. This report proposes a framework to explore how a building tenant could improve the performance of the occupants in high performance low carbon buildings through organisational processes relating those back to the physical features of buildings and employee perceptions. This report identifies the organisational practices that tenants can incorporate to improve well-being and productivity of their staff working in high performance low carbon buildings. The methodology consists of a Systematic Review to identify relevant studies on high performance low carbon building interventions that impact employee's well-being and productivity. However, it goes further by conducting a series of Post Occupancy Evaluation studies to identify and measure the employee benefits of high performance low carbon buildings.

Part 1: Systematic Review

Organisations are already generating a massive amount of data that could yield immediate improvement strategies for their two biggest expenses – people and places, and the relationship between the two. This can be done by encouraging businesses to undertake a review of these aspects for themselves in their own buildings. The main aim of the systematic review is to summarize what we know (and do not know) about embedding organisational practices by the tenants to provide a framework for thinking about the practices that may support occupants' performance. The systematic review in the first part of this report was designed to identify key areas identified from the systematic review to enable CRC partners and members to plan further research and foster project initiatives. As such, this study is conceived to benefit educational, government, industry and community groups across Australia.

Part 2: Survey

The next part is intended to provide the stakeholders of building design with greater clarity on the organisational practices that impact wellbeing and productivity in the workplace, and the challenges and opportunities in translating outcomes into financial metrics. This includes practical suggestions from the survey participants (occupants of the high performance low carbon buildings working at management and employee level) on how to use the key functions in a consistent and robust way. In due course, it is hoped this will to inform investment and design decisions to develop transparent communications between the owners and tenants to maximise benefits to occupants at an individual level as complementary to strategies to reduce energy and resource use. The intention is to increase understanding the relationship between building and user, and the financial impact of that relationship. This part of this report will encourage the CRC industry partners and members to support capacity-building engagement beyond just technical elements of design features of high performance low carbon buildings. This approach will enable the opportunities and insights to bring all the stakeholders together for a common cause on how office buildings influences people and how occupants (working at individual level) can improve the performance of these buildings.

Links to CRC vision and CRC milestones

The 'Closing the Loop' project aims to connect academic research evidence with the front-end decision making process of built environment industry, in order to lead to the development of the next generation of low-carbon, high performance built environment projects. The project considers two primary streams:

Theme 1: Evidence for Low Carbon, Health and Productivity Outcomes – development of an evidence assessment process for the low carbon, health and productivity benefits of design, engineering and management-based building interventions, including review, assessment, analysis and synthesis of the global evidence base.

Theme 2: Building Project Decision-Making – analysis of the evidence used during the decision making process in the pre-project, briefing, design, construction and operational stages of a building. This will help to determine when, in what form and to whom the evidence should be delivered to ensure its most effective impact and use.

Based on Closing of loop's first theme, this project evaluates the gaps in research and implementation of high performance low carbon office spaces from the end user perspective. Based on the second theme, the study seeks to understand how the design information and management's processes influence occupants' green behaviours that eventually influences their performance. In doing so, the study provides valuable guidance to CRC Milestones: The completion of empirical case study post occupancy analysis exploring the benefits of high performance low carbon buildings from the tenants' perspective. The report outlines the organisational processes identified from the survey that will be beneficial for the different stakeholders of high performance low carbon building design.

Scope

The study about behavioural dimensions of occupants in high performance low carbon buildings is a complex issue, so to retain focus, this report deals only with office buildings. While lessons could certainly be learned from other building typologies, it was necessary to narrow the scope of this research and to eliminate additional factors that may have further complicated the methodology and findings. High performance office buildings were deemed as the most appropriate building type to study because (a) office buildings represent a the largest portion of the commercial building sector (17%) and, (b) the majority of existing published Post Occupancy Evaluation (POE) studies are for office buildings, so results can be compared (Day and Gunderson, 2015). Research is cited from public and private sectors where there is relevance. Similarly, the findings have resonance

beyond just the office sector. An exhaustive process of evidence gathering has been carried out, informed by a project team which was able to draw on industry and academic experts from across different disciplines, sectors and locations. Wider outreach was conducted at particular points throughout the process, including detailed surveys of management professionals that are involved in occupant's behaviours. Exploratory research was undertaken with CRC participant representatives and leading industry expert groups through quantitative survey methods in parallel with systematic review methods, to identify the critical gaps in the research and the preferred methods for better performance outcomes in the office spaces.

This report will build momentum on the topic of wellbeing and productivity. It does not set out to solve all of the challenges, but we hope it helps to provide a framework for doing so. It is aimed at a mainstream, non-technical real estate audience who are rightly eager to understand the business benefits of greener, healthier buildings. It is not primarily aimed at sustainability professionals at technical and design sectors, but we hope it will used by them in their discussions with clients, colleagues and customers. Based on the key CRC areas aligned to the current demand for; gaps in the implementation occupant's behaviour in high performance low carbon buildings:

- systematic literature review and mapping, to inform the designers, architects, engineers to improve communication with the building owners and tenants about the building information
- survey the participant organisations will generate a feedback loop from end users to inform all the stakeholders involved to explore alternatives to improve performance beyond technical design features of the buildings

Definitions for the purposes of this study

The terms wellbeing and productivity are used to encompass a whole range of related and complex issues. For instance, the concept of wellbeing has expanded in recent years, much beyond the work in early studies. This is because of a greater awareness that attitudes and perceptions are every bit as important to work outcomes as physical conditions. Wellbeing hints at broader feelings or perceptions of satisfaction, identification, and commitment towards the organisation. Ironically, defining productivity often involves numerical terms such as time lost according to sick leaves, for example. Therefore, demonstrating the relationships between office environments and employees' performance is challenging.

In this study, productivity tends to be used to refer more explicitly to business-oriented outputs involving the occupant's job performance and work related flow. We have addressed very transparently the ways in which strategies to maximise wellbeing and productivity outcomes are compatible with (and even enhanced by) strategies to minimise energy and resource use. There is often a 'virtuous circle' of good design that works for both people and planet; as well as demonstrating a positive environmental performance at employee and organisational level. In any case, the report findings undeniably affirm that buildings can maximise benefits for people, and leave the planet better off as well. Low carbon, resource efficient, and productive – fundamentally, this is about high performance low carbon buildings.

Ethics Clearance

During data collection, the researcher took steps to avoid any potential ethical issues and ensured that the research activities generated no adverse effects on participants, such as worries, nervousness, loss of self-esteem, or a sense of failure. The researcher first applied for ethical approval from the faculty Human Ethics Advisory Group (HEAG) at Curtin University to ensure that the research design and the research package, including questionnaires, met ethical standards such as autonomy, non-maleficence, beneficence, and justice. Further, the study ensured that participants were informed about study nature, aims and process, how the data would be used, and the potential consequences of the research. Before conducting the fieldwork, the researcher prepared the Informed Consent Form, which contained a statement about the research. Finally, this research made every effort to guarantee confidentiality and anonymity. Participants involved in this study were coded anonymously to avoid any disclosure of identifiable data. The data collected was retained in a secure location, only the researchers had access to the data, and only de-identified and aggregate data were to be reported in any publications.

Structure of the Report

The main body of this report contains four chapters. The first chapter introduces the topic. The background to this research, aim and links to CRC vision and milestones are outlined. The next chapter is the systematic literature review that analyses previous research on the topic. The third chapter discusses the findings from the post occupancy evaluation surveys conducted on employees and managers working in high performance low carbon buildings. The final chapter consists of reporting key findings of this study and those aligned to CRC milestones. This chapter also highlights the future priority areas based on the limitations of this study.

Systematic Literature Review

The evidence-based movement has had a major impact in certain disciplines such as medicine and health. Over the last decade, medical science has made significant strides in attempting to improve the quality of the review process by synthesizing research in a systematic, transparent and reproducible manner to inform policy and decision-making about the organization and delivery of health and social care. The Cochrane Collaboration produces and disseminates systematic reviews of healthcare interventions and promotes the search for evidence in the form of clinical trials and other intervention studies. A decade later, these ideas were adapted in the field of management and organization studies. The use of systematic reviews has been extended to other fields since the 1970s (Petticrew, 2001), but not yet to the synthesis of behavioural research (Sheehan et al., 2010). The growth of interest in evidence-based practice has increased pressure on practitioners to demonstrate that their existing work and their new practices are based on the best available research evidence. The increasing amount of research information, which varies in quality and relevance, can make it difficult to respond to these pressures, and can make the integration of evidence into practice difficult. To help practitioners manage the rapid increase in available evidence, systematic reviews were developed as a tool to collate (systematically search the available literature); filter (identify credible sources of evidence); synthesize (analyse the body of evidence to determine the overall effect of an intervention); and disseminate the evidence for the effectiveness of potential and currently used treatment options on a topic for practitioners (Higgins and Green, 2005).

To complement existing reviews, a systematic approach is adopted to evaluating what has been written about the tenants at organisational level in improving performance of occupants in high performance low carbon offices. This systematic review is critical in developing and researching programs aimed at achieving the CRC's targets immediately and into the future. Prior to beginning the review, a review panel was formed encompassing a range of experts in the areas of both methodology and theory. Efforts were made to include practitioners working in the field on the panel. The review panel directed the process through regular meetings and resolved any disputes over the inclusion and exclusion of studies. The initial stages of systematic reviews was an iterative process of definition, clarification, and refinement. This study adopted some but not all of the elements of the traditional methodology of systematic review in the management field. These included a commitment to make the literature review replicable, scientific and transparent (Tranfield et al., 2003), and establishing the required steps to frame the enquiry and present the results. However, the emphasis is not on the quantitative analysis of articles (except where this is directly useful to the elucidation of concepts and frameworks), but rather to provide conceptual clarity for management influences in high performance low carbon building design and the identification of areas where knowledge is still lacking. The authors are more comprehensive in terms of the literature they examine and are purposely more descriptive in terms of what is found-leaving it to the articles and authors to reveal what they consider to be the core concepts they are defining and investigating. Hence, the focus of the analysis is not authors and articles in the first instance, but rather concepts and themes that emerge from the text of the published articles. The authors treated the material gained from the systematic review as a set of concepts, questions and issues that are of interest to academics, policy-makers and practitioners. In this sense, the approach builds on a conceptual synthesis, though with fuller coverage of the literatures, and using data extraction sheets (used in systematic reviews) in order to make the sources of material and their evaluation transparent. The reason for taking this particular approach in relation to management interventions in high performance low carbon building design is that this field of research lacks the use of such approaches to draw evidences.

The systematic review approach for this chapter is employed because of issues such as:

- There is a wide range of research on the subject of user centric design in high performance low carbon buildings but the key questions remain unanswered regarding how much importance need to be given to the human dimension in high performance low carbon building design.
- There is an uncertainty about the effectiveness of the tenant's influence in high performance low carbon buildings impact on employees productivity and wellbeing or whether the technical aspects of high performance low carbon buildings design is most significant driver
- Whether a general overall picture of the evidence in management influence in high performance low carbon buildings needed to direct future research efforts
- Whether systematic reviews can be the accurate methodology to draw evidences of significance of management impacts in high performance low carbon buildings

Methodology

Prior to beginning the review, a review panel is formed encompassing a range of experts in the areas of both methodology and theory (Tranfield et al., 2003). Efforts were made to include practitioners working in the field on the panel. The review panel directed the process through regular meetings and resolve any disputes over the inclusion and exclusion of studies. The initial stages of systematic reviews may be an iterative process of definition, clarification, and refinement (Clarke and Horton, 2001).This study adopted some but not all of the elements of the traditional methodology of systematic review in the management field. These include a commitment to make the literature review replicable, scientific and transparent (Tranfield et al., 2003), and establishing a number of steps to frame the enquiry and

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The review methodology consists of three distinct steps: (1) selection of journals; (2) development of key categories and analysis framework; (3) selection of articles (Delgado et al 2015). This process can be further divided into seven steps referring to (Tranfield et al., 2003)

- Identification of keywords and search terms, which are built from the scoping study, the literature and discussions within the review team.
- Deciding on the search strings that are most appropriate for the study.
- The search strategy will be reported in detail sufficient to ensure that the search could be replicated
- The output of the information search should be a full listing of articles and papers (core contributions) on which the review will be based
- Only studies that meet all the inclusion criteria specified in the review protocol and which manifest none of the exclusion criteria need be incorporated into the review.
- The strict criteria used in systematic review are linked to the desire to base reviews on the best-quality evidence.
- As decisions regarding inclusion and exclusion remain relatively subjective, this stage of the systematic review might be conducted by more than one reviewer. Disagreements can be resolved within the review panel.

Reliability of inclusion and exclusion decision and assessing the quality

At the outset of this review, a team of five panel composed of senior business school academics and practitioners in order to critique the progress of the work. A) Academics were selected with an interest and background in built environment, health and business, and (B) practitioners from built environment. Standards for inclusion were set, and three researchers independently assessed and then cross-referenced judgements on the papers. These standards included a requirement to ensure all articles were properly categorized, a two-step procedure as suggested by Delgado García et al. (2015) was used. First, two authors separately analysed the full text of the articles to assess the extent to which each article addressed the topics involving some kind of management's interventions in green buildings. Second, the two coders solved their disagreements through discussion. When there was doubt about the content or discrepancies between the two authors on the inclusion/ exclusion of an article, the full text of the article was examined to assess its relevance. In consultation with the review panel, the relevant business and management bibliographic databases, database domains/topics/subjects and search keywords were identified.

The criteria for systematic review as suggested by Tranfield et al. (2003) was followed. The review focused on peer reviewed journals and conducted a series of keyword searches in four different types of databases to include studies from both management and built environment: (1) ProQuest's ABI/INFORM; (2) Scopus; (3) ScienceDirect; and (4) Business Source Complete.

Topic	Inclusion criteria
Date	• Articles published between 1990-2016
Geographic Location	• Including all the locations
Language	• English
Publication	• Original research papers
Publication bias	• Peer-reviewed journal articles
Setting	• Green office buildings
Participants	• Employees or managers Empirical and non-empirical studies
Design	
	Exclusion criteria
Publication	• Exclude duplicate papers, grey literature and review papers
	• Excludes articles focusing on technical features such as health, medicine or built environment
Setting	• Excludes low carbon offices other than commercial office buildings
	• Excludes articles that do not have any relationship between sustainability and organisational culture
Design	• Excludes articles with no relationship with managerial interventions to incorporate behavioural and cultural change in green buildings

Keyword Analysis and Generating search strategy

The coding process involved two raters. The review team identified keywords on the subject based on their prior experience. These words were identified using a form of brainstorming. They drafted a list of major keywords by grouping those provided by the authors and the library databases into coherent categories. They independently reviewed the list and discussed the disagreements. This led to a final list of 22 major keywords into four categories: green buildings, productivity and wellbeing, core business related keyword and performance outcomes. Based on the keywords, the following search strategy was finalised.

(TITLE-ABS-KEY ("Green building*" OR "sustainable building*" OR "LEED" OR "green star" OR "intelligent building*" OR "green office*" OR "sustainable workplace*" OR "green design") AND TITLE-ABS-KEY (productivity OR wellness OR well-being OR wellbeing OR wellness) AND TITLE-ABS-KEY (manage* OR leadership OR "human resource management" OR hrm OR polic* OR education OR training OR perception* OR engagement OR culture OR satisfaction) AND TITLE-ABS-KEY("Environmental performance" OR "environmental proactivity" OR "Productivity" OR "employee job performance" OR "Organisational identification" OR "Organisational commitment" OR "job satisfaction" OR "work related flow"))

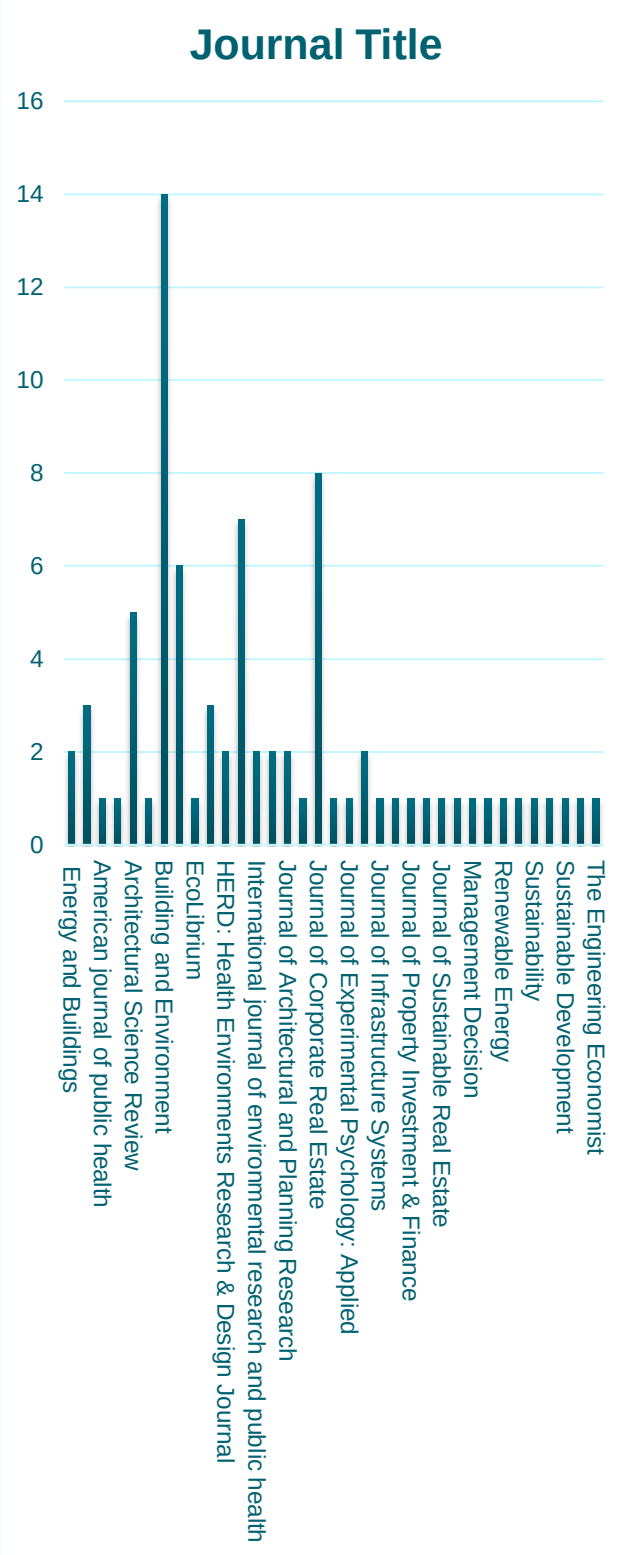
Results

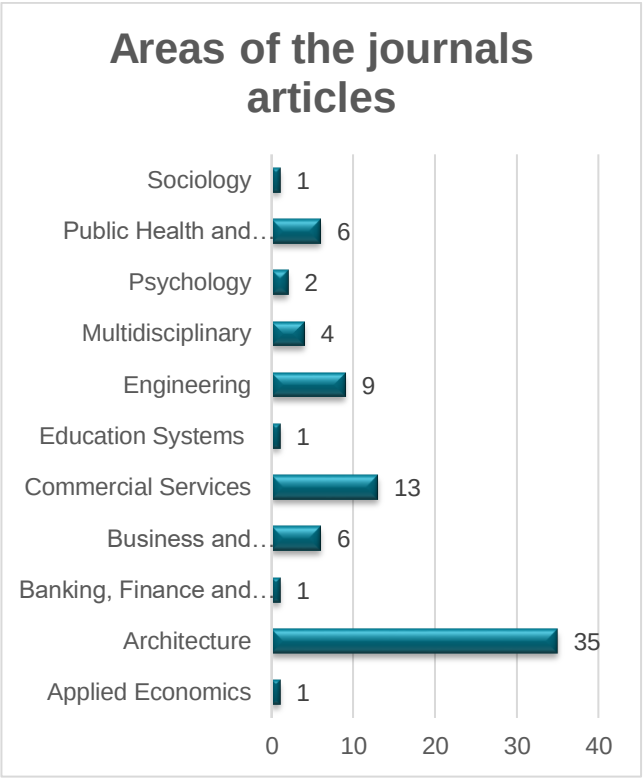
Given that behavioural studies in high performance low carbon buildings is a broad topic, we initially cast a wide net. This initial search strategy generated a long list of 379 papers. The performance outcomes keywords further narrowed the number of papers to 218, with 89 papers identified from Scopus, 90 from ProQuest, 14 from Business Source Complete and 25 from ScienceDirect. The selection of studies was undertaken by subjecting each paper to a series of criteria, with reasons for inclusion and exclusion being noted. The initial title and abstract screening included 138 papers. Many papers were excluded because they were either not relevant to the topic or not relevant to the context of office buildings. Further removing the duplicates allowed 95 papers for a full review. One article could not be retrieved to make assessment, thus full copies were retrieved for a total of 94 articles. The next stage involved examining the quality of the articles as set by the review panel. This included the articles appearing in high ranked journal and having higher impact factor. This process reduced the number to 66, which were selected for a full text review. The 66 articles were scrutinised based on the discussion and emphasis on management interventions. Of these 15 articles were excluded because no links were found related to the topic of interest. The reference list of 51 articles were searched subject to inter-rater reliability of 0.96 using Kappa Statistics (to ensure high level of reliability/trust in the process) to further select 27 articles for full text review. An additional two articles were suggested by the expert panel. Among the total 80 articles, 26 articles were found to be theoretical and among the rest 54 articles were empirical, while 48 articles were found for quantitative synthesis, three articles each were found for a mixed and qualitative synthesis. The review procedure is summarized in Appendix 1.

The search strategy aimed, as far as possible, to eliminate bias and be widespread by using a database search, cross-referencing between researchers and applying agreed inclusion criteria at each stage. The review process was iterative. Using this data, we conducted extensive, detailed analysis and synthesis of the materials to extract the various practices that may support embedding tenant's involvement in improving performance. The outputs of this systematic review are useful for a range of stakeholders, most importantly those who might benefit from highlighted knowledge gaps, suggested improvements, best practices, leading edge and reliable studies.

Articles

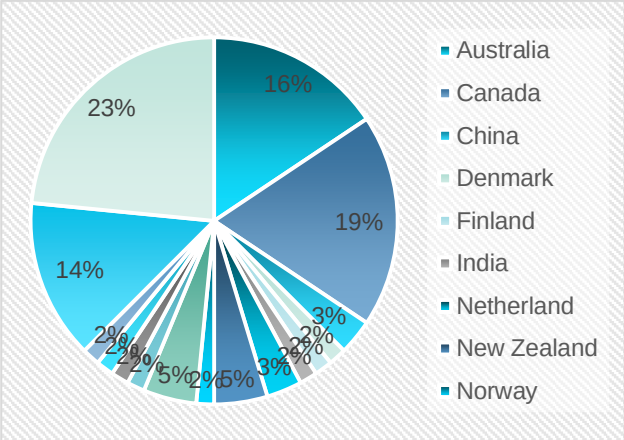
In terms of journal title and type the significance of management in high performance low carbon building design was not found to be a focus of management research so far. Only 8% of the papers were from researchers with a core Business and Management background. Among them Facilities Management had highest number of articles. Apart from core Business Management area, some related areas such as Psychology with two articles and one article from the area of sociology can be found. Most of the papers, about 44% were in the areas of Architecture, with Building and Environment having highest number of articles, 14 in total. The next most common three disciplines were Commercial Services, with 13 (16%) papers; Engineering, with nine (11%), and Public Health, with six (8%). Other disciplines were represented but their contribution is not substantial. They are two articles from Education Systems and one each from Applied Economics and Banking and Finance. Few articles were from multidisciplinary fields, four in total (5%) focusing on sustainability and environment.





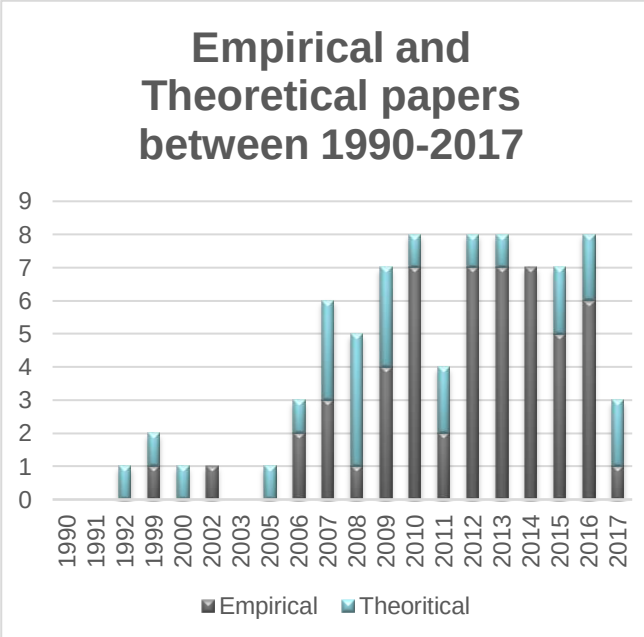
Geographic distribution

In terms of the geographic distribution of studies, it is interesting to note that even though non English papers were not included, the results highlights that the study of high performance low carbon buildings and employees' productivity and wellbeing, with management evidences can be traced in many countries. Of 80 papers included in the review, the majority of the evidence on management's influence on employees' productivity and wellbeing in high performance low carbon building is located within United States, followed by Canada and then Australia and United Kingdom, with about 57%. The remainder of the articles were from China, India, Denmark, Finland, Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, Taiwan, and UAE. One of the reasons could be that most countries are of non-English background and thus articles on the topic might not have appeared in the searches for different keywords.



Methodological choice

Of the 48 quantitative studies selected, surveys is the most common methodology used as the data collection method. Very few studies employed simulations and experiments. There were three articles each with a qualitative focus and employed a mixed method design. Almost all the studies were almost exclusively cross-sectional (90%) explain. Few studies that were longitudinal in nature, case study comparisons, combined survey and archival data. It was striking to know that most of the data collection did not focus on core management area of studies but on built environment related disciplines. The management influence or some of the areas that management can control in high performance low carbon offices were either a part of the literature studies or in the findings. However, 26 theoretical articles had extensive discussion on organisational areas such as job satisfaction, behavioural or social or psychological needs and outcomes of employees' in high performance low carbon buildings.



A Portfolio of Practices for improving performance in high performance low carbon buildings

In constructing this review, we are not addressing the technical elements of high performance low carbon buildings such as Indoor Environmental Quality (IEQ), lighting or acoustic as performance outcomes. Instead, this review is targeted at those tenants that have made some strategic choices about their pursuit of performance and in the process, have identified a need to strengthen their organization's practices in order to achieve greater performances in such buildings. Consequently, in conducting our analysis of the available literature in this area, our focus was on organizational practices that build and support design features of buildings intended to perform better than a traditional building. We examined these different practices and grouped them in a way we anticipate will be meaningful for businesses. The practices varied on two main dimensions relating to intent and their approach. These two dimensions are described below.

	STRATEGIC LEVEL	OPERATIONAL LEVEL
INTENT	• Competitive Advantage, Organisational Culture, Stakeholder involvement, Corporate Image, Environmental Control	• Behaviour, Satisfaction, commitment, Presentism, productivity
APPROACH	• Attraction and Retention, Leadership, Incentives and Benefits, Initiatives	• Training and Awareness, Engagement, Flexibility, Team Building, Feedback

Intent: What are you trying to accomplish?

The practices were grouped into two different intentions that the tenants might incorporate to enhance the overall functioning of the buildings to its desired performance level. At the strategic and operational level, these intentions are the unique selling points that the designers, architects, and engineer can make to the building owners and tenants on the importance of high performance and low carbon buildings.

Strategic level

Practices aimed at a strategic level will be useful to create a unique identity of tenants that rent in high performance low carbon office buildings. These are

macro level practices involved at an organizational level influencing the performance of the occupants.

Operational level
In contrast, practices aimed at operational level were those that intended to find the impact of the high performance low carbon buildings directly on the occupants. These practices involved discussions on what the organization could emphasis at employee level to receive direct benefits of such buildings.

Approach: How are you going about it?

The practices were also grouped into two different approaches to meeting goals of higher performance at both strategic and operational level. There is an ongoing interplay between these two approaches and both impact performance culture. Managers should be aware of the existence and impact of these approaches to incorporate the occupant's engagement in building design.

Strategic level
At a strategic level, practices involved policies to improve the motivation of performance of occupants working in such building to embrace the design features as culture of the organisations. This is often accomplished by attracting external pool or motivating internal occupants to stay with the organisation for longer term.

Operational level
These practices aim to establish and reinforce the behaviour required to adapt to the design features of the building. This is often accomplished by generating a direct engagement through certain workplace functions.

As we compared the practices, we found that they appeared to target three level of performances: environmental performances, economic performances and employee performances. On the path to create the business case for high performance low carbon office buildings, this review found that the existing performance outcome might cater to energy efficiency, or improving the work productivity or wellbeing pertaining to employees satisfaction and commitment working in those buildings.

Intention at strategic level

Competitive Advantage
The review found that tenants can regard environmental responsibility as a competitive issue. The stakeholders involved in high performance low carbon buildings can consider the environmental aspects taking into account the life-cycle performance of these buildings in terms of cost effectiveness, marketability and overall maintenance efficiency, to affect the behaviour of the external groups to perceive the uniqueness of such tenants. These trends can enable a tenant's brand building, business development, and marketing strategies to have a competitive advantage.

Stakeholder engagement
The construction and design processes need to have a primary aim directed towards making buildings healthy for working and living in. Many stakeholders need to be involved in the implementation of solutions (e.g. architects, facility manager, construction industry, building scientists, communications specialists and code officials). Collaboration of all stakeholders will likely result in assessing risk and develop guidelines to improve performance in these offices. One such stakeholders are tenants that can be involved with different groups to improve greater competitiveness, improved productivity, healthier lifestyles and social cohesion through the ethos of work.

Corporate Image
There is a growing recognition that high performance low carbon buildings may play a crucial role in promoting the green practices at work as a whole (Heerwagen, 2000). The contemporary workplace is expected to provide a whole host of benefits including a reassuring atmosphere, compensation for the abstraction of work, protection of workers from stress, unification of the organization, expression of organizational values, motivation and mobilization of staff, promotion of sociability and cooperation, and reflection of a tenant's desired image. The building itself is a symbol of the tenant's environmental and social performance, and it may be a powerful source of attraction for potential employees. Investors strongly believe that a building designed in sustainable way providing performance benefits adds value to the business.

Organisational Culture,
The organisational policies of the tenants occupying high performance low carbon buildings, although not direct building-related factors, could affect both occupants' satisfaction and the building's energy consumption. The significance of the physical environment in organizational culture is to be found in the symbolic and social roles of physical structures within an organization (Gibson, 2008). There are potentially significant gains to be made from integrating high performance low carbon buildings with workplace design strategies from the outset, there are many other factors beyond the quality of the space, which may play a role in shaping user experience. Based on the findings from the review, we indicate possible links between improved occupant comfort, health and productivity, and organizational culture. Tenants who want to use these buildings to enhance organizational values and benefits can make their case.

Environmental Control
The review findings indicate that there is a positive relationship between occupants' satisfaction and their self-reported productivity. One such factor which contributes to occupants' improved satisfaction is occupant's personal control over the environment (Agha-Hossein et al., 2013). Increasing control given to occupants not only typically improves occupant's physical and psychological sense of comfort and well-being but can also result in significantly lower levels of energy consumption (Steemers, 2010). From a business standpoint, the simplest explanation is that if the tenants enhances the occupants' understanding on the building

and environmental control systems, then they may contribute to lower building energy use, which ultimately costs the owner less money, and they may increase their overall satisfaction with the interior work environment. This is a win/win situation for both the building owner or tenant and the building occupant'(Day and Gunderson, 2015). Building environmental control systems are designed to accommodate more direct forms of active user engagement through the opening and closing of windows, blinds, switches, and other manual controls. As a result, the successful performance of high performance low carbon buildings depends in a large part on variation and diversity in environmental conditions, where both the building systems and inhabitants interact and adapt in response to changing external conditions and needs (Brown and Cole, 2009).

The review found a positive correlation between perceived personal control over the physical environment and self-reported job satisfaction. Psychological comfort results from feelings of belonging, ownership and control over workspace. Management issues should be considered in the design of workplaces while considering greater control.

Intention at operational level

Behaviour

The review has identified the need for a broadening of current post-occupancy evaluation methods to include a wider range of behavioural, situational, and socio-psychological measures which can have real impacts not only on building energy performance, but also on comfort and satisfaction (Brown and Cole, 2009)(Brown and Cole, 2009)(Brown and Cole, 2009). Physical aspects of the buildings such as temperature, air quality etc. did not decrease work-related interactions, but did reduce non-work-related interactions, contending that social exchanges can influence morale and cohesiveness. This also linked to the "status" of workers, where higher-level positions tended to face out. In some cases occupants facing inward considered this demeaning (Tucker and Smith, 2008).Occupant behaviours in high performance low carbon buildings may be affected by many factors including occupant comfort (or discomfort), social influences, or lack of knowledge surrounding building systems. The tenants can improve specific behaviours of the occupants to use the design features as intended.

Productivity

The cost of the lost productivity can be estimated in terms of staff wages and hence potential payback periods for different adaptation measures could be estimated according to how much thermal comfort is improved (Kershaw, 2013). Functional comfort links psychosocial aspects, including worker motivation, with workspace elements and thereby with organisational productivity by measuring environmental support for task performance (Vischer, 2008). Behavioural and social aspects such as privacy, collaboration, interaction and distraction are subjective and influence occupants' productivity. This review emphasises that the behavioural environment is an integrated dimension of an office environment, and it affects occupants' behaviour and the social environment that are created and evolved by office workers. The tenants can create strategies, to develop work patterns influencing the physical and behavioural components constituting the office environment. This will have a collective impact on office productivity.

Satisfaction

Occupant satisfaction was intended to reflect both social and economic factors related to a building's sustainable performance, its effect on people's health levels, and the efficiency of the building's space utilization (Li, 2015). For example, the review found significant differences between different groups of workers in satisfaction with the physical environment, but only for the office workers who worked during the day and not for shift workers. The occupants rated the effects of noise, office furniture and the overall workstation design as being associated with satisfaction and for a majority this was positive. The tenants can use practices at an operational level to directly influence the satisfaction of the occupants with their office design.

Commitment

The review found that only employees who feel comfortable within a company will contribute in an effective and committed manner (Cajias et al., 2012, Edwards, 2006, Sadatsafavi and Walewski, 2013). The feeling of contribution and meaningfulness is essential to productivity and contribution at work. The results here clearly show that the leadership team from the tenant side have a direct role in the development of initiatives (maybe due to job role) to impact the workplace satisfaction that can indirectly improve commitment to the organisation. In conjunction to the physical benefits of the buildings, the tenants can provide autonomy; job enrichment and opportunities to use one's skills are associated with strong feelings of organizational commitment. If the affective organizational commitment positively correlated with the number of green design attributes, the physical environment could be advanced as an additional factor to further develop models of organizational commitment.

Presentism

This review noted that most organizations experience a drop in productivity in short term when workers move buildings. This would imply that even if productivity measures remain similar despite a major organizational intervention, such as a change in office building, this might actually be a positive indicator. Improvements in perceptions of physical wellbeing are also likely to translate into improvements in psychological wellbeing and productivity over time (especially absenteeism and presentism), provided the improvements are maintained. That sustainable design features are incorporated into the building design, does not guarantee that they will be commissioned properly by facilities managers or that building occupants will use the design features as intended until the tenants links the presentism as major strategy to improve productivity.

Approaches at strategic level

Leadership

The prevalent practice of managing and examining through a quantitative/technological focus without cognisance of the social/qualitative dimension of occupants' needs leads to a 'commitment to an unsustainably standardised future(Thomas, 2010).What is lacking in the indicators for productivity is some idea of the magnitude of both social and environmental factors. Designers constantly strive to create conditions that bring out the best in people and add value to investments and services. Tenants will also usually want to achieve reasonable conditions for themselves. To further complicates matters, tenants and occupants can all behave perversely as well. The review reveals that the tenant's organisational structure displays can impact on the implementation of green practices if their core leadership team are motivated to behave normatively in protecting the environment or assuaging stakeholder concerns as well as connecting to the occupant's productivity and wellbeing.

Initiatives

The review found that the availability of location and amenities in addition to the environmental features of high performance low carbon offices can improve the overall productivity and wellbeing of the occupants. The tenants can place emphasis on cycling, public transport under the location and amenities factor. The proximity to public transport facilities, healthcare/ clinic facilities, childcare facilities, recreational space and sports facilities, and entertainment facilities can overall impact to greater motivation to work for the tenant organisation located in those buildings (Al Horr et al., 2016).

Attraction and Retention

The link between high performance and low carbon buildings and improved labour retention rates have been heavily documented (Wright et al., 2006). Having a sustainable office was increasingly viewed as a factor in recruiting staff, with several participants indicating that potential staff (Miller and Buys, 2008). The tenants can advertise their green space when posting positions to attract knowledge workers. While innovative workplaces may be challenging to measure, new techniques must be developed to measure their impact on users in organisations that are already convinced that innovative workspace can make a difference on employee recruitment, retention and productivity.

Incentives and Benefits

There are taxation benefits and incentives for tenants located in high performance low carbon buildings. The benefits are gained from reduced energy use. However to further motivate the occupants using the design features of the buildings in way that is more effective, the tenants could incorporate incentives and benefits at their job level. People's behaviours often echo what they perceive as the norm. Thus, it is important for companies to create an environment in which employees are encouraged to interact with the building with the goal of energy savings. There are many ways to nudge occupants into changing their behaviours, including providing feedback and/or incentives, goal setting, and competitions (Day and Gunderson, 2015).

Approaches at the operational level

Engagement

Employees often have an energetic and effective connection with their work and look upon it as challenging rather than stressful (Bakker, 2008). This review found that previous research is highlighting that poor design can result in disengagement such as distraction, lack of interest, poor decision-making and high absence rates. This review confirms the value of user engagement in the ongoing management of the building. This aspect was crucial not only for the facilities personnel to understand user needs, but also to enable users to increase their understanding of the design intent of building and develop a sense of 'ownership and pride in their workplace' as well as ensuring that the tenancy reached its energy and carbon-reduction targets through their participation (Thomas, 2010).

Flexibility

Current trends in workplace design include: a greater emphasis on flexibility, both in work schedules and organization of space, as the assumption of occupant's personal ownership of workstations being replaced by increasingly mobile workers (Worthington, 2009). The tenants could emphasise on the internal arrangement of workspace reflecting firm's corporate culture.

Training and Awareness

Several papers included in this review indicated that occupants' lack of awareness or understanding of the building's environmental systems and features, and action strategies that can be taken to influence comfort conditions. The tenants can improved the awareness about their buildings amongst staff. It is recommended that communication be improved between management and employees. This may result in increased satisfaction and less complaints, longer retainment of employees, and better marketability and branding of the tenant organisation (Kato et al., 2009).

Team Building

In a high performance low carbon building, the team must engage early and in a more integrated and collaborative fashion that requires resources and a new form of thinking. During a design charrette in a green construction process, all team members are challenged to discuss and adjust design parameters that are traditionally made in isolation (Hoffman and Henn, 2008). In similar fashion, the tenants organisation could build dedicated staff resources to develop initiatives and practices for greater occupant's engagement in the design features of the buildings.

Feedback

The initiatives and practices can be improved through a positive feedback mechanism. Feedback could impact the behaviours in high performance buildings that can reinforce the social cues or norms within a given building. Thus, it is important for tenants to create an environment in which employees are encouraged to interact with the building with the goal of energy saving through feedback.

Proposed and weakly supported organisational strategies

Apart from the above-mentioned areas, there are other strategies that the review found to have limited visibility in the previous research, yet these practices and approaches are worth mentioning, as this will provide a wider net to capture the tenant's initiatives to improve performance of the occupants in future studies. These areas are emphasized in both the theoretical and empirical articles and have potential links to productivity and wellbeing in high performance low carbon buildings. These concepts are:

- Strategic performance
- Human resource development
- Human resource management
- Motivation
- Job security
- Social comfort
- Psychological benefits
- Environmental psychology
- Environmental attitudes
- environmental perception
- Organisational citizenship behaviour
- Personal capabilities
- Organisational identity

Performance outcomes

Specific aspects of environmental, economic and employee performance were examined to understand the organisation's influence in enhancing employees' attitudes to perform better in high performance low carbon buildings. Out of 80 articles that were selected for review, 45 studies supported organisational initiatives for environmental performances and 29 articles supported environmental proactivity of organisations. In particular to organisational performance, operational outcomes such as productivity was supported by 54 articles, among which 2% showed no association of employees' productivity with high performance low carbon buildings. Employee job performance as a part of economic performance was highlighted in 24 articles. Similarly, at an operational level, psychological wellbeing in terms of job satisfaction and organisational commitment by 96% of the articles. Only affective form of organisational commitment that correlates with job satisfaction was highlighted. Employees' engagement in terms of work related flow in green certified offices was found in 16 articles.

	NO OF STUDIES	SUPPORT	NO ASSOCIATION	OPPOSITE OR AGAINST
ENVIRONMENTAL PERFORMANCE	74	74 (100%)	0 (0%)	0 (0%)
ECONOMIC PERFORMANCE	79	78 (98%)	1 (2%)	0 (0%)
EMPLOYEE PERFORMANCE	122	118 (96%)	4(4%)	0 (0%)

Economic Performance

Research suggests that behaviours of occupants in high performance low carbon building comprises of various behaviour and social dimensions in a workplace, that affects the overall occupant's comfort, and ultimately influencing office productivity. Among the articles under the review, there is a strong connection between high performance low carbon buildings' environmental performance and economic performance particularly productivity. The dimension of behavioural environment is argued to be the intangible benefits of green buildings and therefore should be a part of organisational measures. The concept of productivity in high performance low carbon buildings in these articles had a broader in scope in the discussion. The organisational level productivity was understood by measuring environmental support for task performance. Further, some articles clearly highlighted productivity with employee wellbeing. Productivity was found to improve when employees have personal control on the green features of the building and this resulted in greater employee satisfaction. Tenants should contribute to the productivity of the organization and facilitate new and improved ways of working such as including strategic Key Performance Indicators (KPIs), providing awareness, initiatives to attract, and creating awareness and retaining workers. The support involves human resources as they could engage employees emotionally. At a more abstract level, it is equally enriching to the occupants to work in a psychologically comfortable environment. The feelings of belonging, ownership and control of the workspace can lead the employees to feel excited or take pride and they are more attached. The deep patterns of organisational meaningfulness is essential for productivity and helpful to retain employees. The organisation culture such as training and participation influences energy use and decreases the resistance to change, thus generating extra role and in role performances from the employees.

Employee Performance

Employees' satisfaction with their workplace design is directly related to their social wellbeing indicator of job satisfaction and indirectly related to organizational commitment. The organisations that operate in high performance low carbon buildings that communicated responsibilities towards environment increases employees' loyalty, morale and commitment to the organisation as well as to sustainability. Evidences shows that job satisfaction as another social wellbeing indicator, is significantly influenced by overall comfort within the buildings and user satisfaction with the physical environment. Occupants in buildings that are satisfied and comfortable with their environmental conditions are found to be more productive. The self-reported job satisfaction is largely due to the personal control to adjust their tolerance with the environment and as well as involving themselves through organisational planning.

Overall, there is strong evidence that wellbeing, particularly, emotional wellbeing, psychological wellbeing and social wellbeing at work is increased in a high performance low carbon building because tenants that operate in such buildings seem to be

communicating employees' behaviours for environment and treat occupants as benefits rather than costs. Design features facilitating workplace tasks also boost occupants' satisfaction. The concept of environmental comfort links the psychological aspects of workers' environmental likes and dislikes with concrete outcome measures such as improved task performance, as well as with organizational productivity through workspace support for work-related tasks. As a result occupants that are excited about their work, are better engaged and thus it is less likely that the person will change jobs.

Environmental Performance

Many studies in this review provided energy efficiency as measurable outcomes of high performance and low carbon buildings. Environmental performance can be mitigated at individual scales, for instance, organisations can motivate their employees to be environmentally friendly. The systematic review highlights that the energy system can be characterised by organisational, operational and social level that can contribute to improve wellbeing and satisfaction and greater environmental awareness. Evidences from the review suggests that individual environmental expectation is satisfied by the right environmental control. Personal control can be argued to bring psychological benefits through empowerment. Typically, tenants, contribute towards better energy efficiency through imparting individual learning and feedback, influencing through rewards. They can also influence psychological processes such as occupants' engagement in green identity, increasing higher environmental satisfaction, personal commitment to sustainability.

The environmental proactivity of an organisation can be highlighted by the leaders' personal commitment to sustainability and environmental responsibility. A higher level of engagement of the senior managers is a critical component of successful green projects such as establishing environmental policies, intending to meet current regulations, minimising its impact, formulating good green practices, establishing green task force and continuing to believe in greening staff.

Conclusion

We propose that tenants can maintain efforts to embed occupants' engagement in building design at both a strategic and operational level. Though we currently have little evidence to support the interactions between these levels, it is likely that practices in one level will support and reinforce practices in other levels. Indeed, the literature on environmental psychology demonstrate the need to employ a portfolio of strategies to improve productivity and wellbeing. The review indicates that there is limited evidence of empirical research that directly measures the practices from the tenant perspective. However, one of the most important findings of this systematic review is tenant's intervention to improve occupants' performance can be achieved through organisational practices to some extent.

It is clear from this review that there is a great need for research in this area. Embedding the tenant level practices required a concrete framework that can be easily followed by different stakeholders to make design decisions. There is a need for researchers to engage with and learn from those practitioners involve in high performance low carbon buildings. Although the task of embedding organisational practices into organizational culture may differ from these other physical design initiatives, we expect that drawing from a portfolio of practices will be necessary to achieve sufficient penetration and traction.

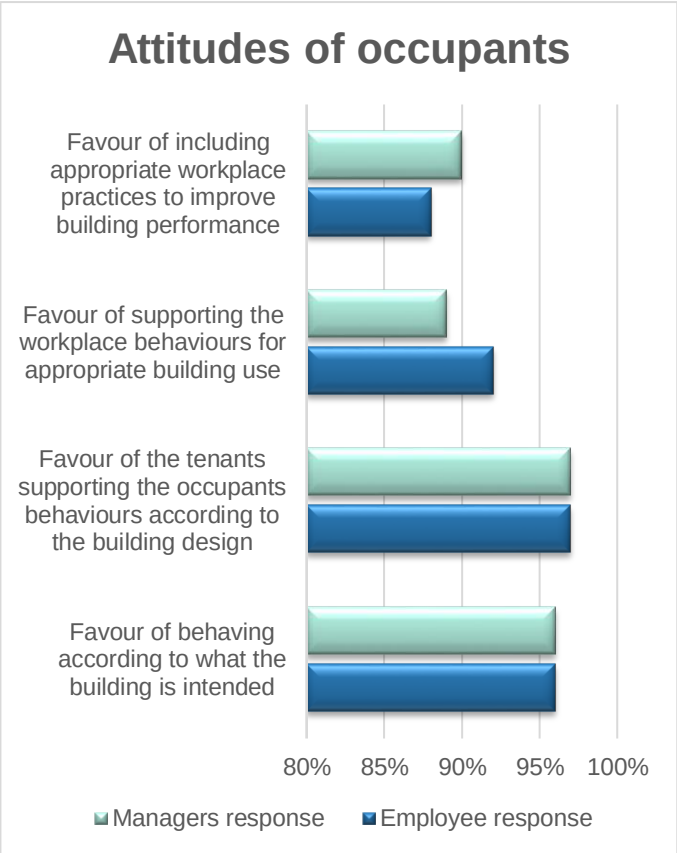
Post Occupancy Evaluation survey findings

The findings from the systematic review indicated that the previous studies emphasise the importance of organisational practices to use the building efficiently. However, these practices are not being implemented to the greatest extent. The findings demonstrate that a lack of post occupancy evaluation surveys that includes socio-psychological dimensions (Heerwagen, 2000) are required to understand building needs effectively. To understand the occupants' behaviours in depth, this study involves conducting two post occupancy evaluation surveys among occupants at employee and management level. The respondents were asked about their attitudes, available resources and how these influences key organisational practices that could improve behaviours and subsequently the performance at different levels in a high performance low carbon buildings. The responses were collected from 623 employees and 99 managers from 21 organisations located in Perth, Sydney, Melbourne and Brisbane. The distribution of the respondents were almost equal based on the gender. Most of the employees responded were from 30-40 years of age and managers between 35-45 years. The detailed list of their demographics can be found in Appendix 2.

Factors influencing occupants' behaviours to adapt to building design of high performance low carbon buildings are outlined. Demand for high performance low carbon buildings is steadily growing across the Australian real estate sector with many industries looking for new opportunities to improve the productivity and reduce the operational costs of the buildings. The building owners are looking to reduce energy bills and the tenants are seeking how occupants live more sustainable and balanced lives. The designers and architects are looking to respond to the challenge to collaborate to successfully complete integrated green design and construction that can eventually achieve the goals of sustainability in construction as well to ensure that the buildings performs the way it is intended to perform. The study revealed the social factors consisting of social and personal norms crucial for occupants' behaviours in buildings. Personal norms represent one's own beliefs and attitudes on how to act. Social norms represent the group-shared beliefs about how members of the group should act and behave. Findings from this survey focussed the tenants' plan and intentions to contribute to CRC's goal to provide guidelines to improve productivity and wellbeing in high performance low carbon buildings.

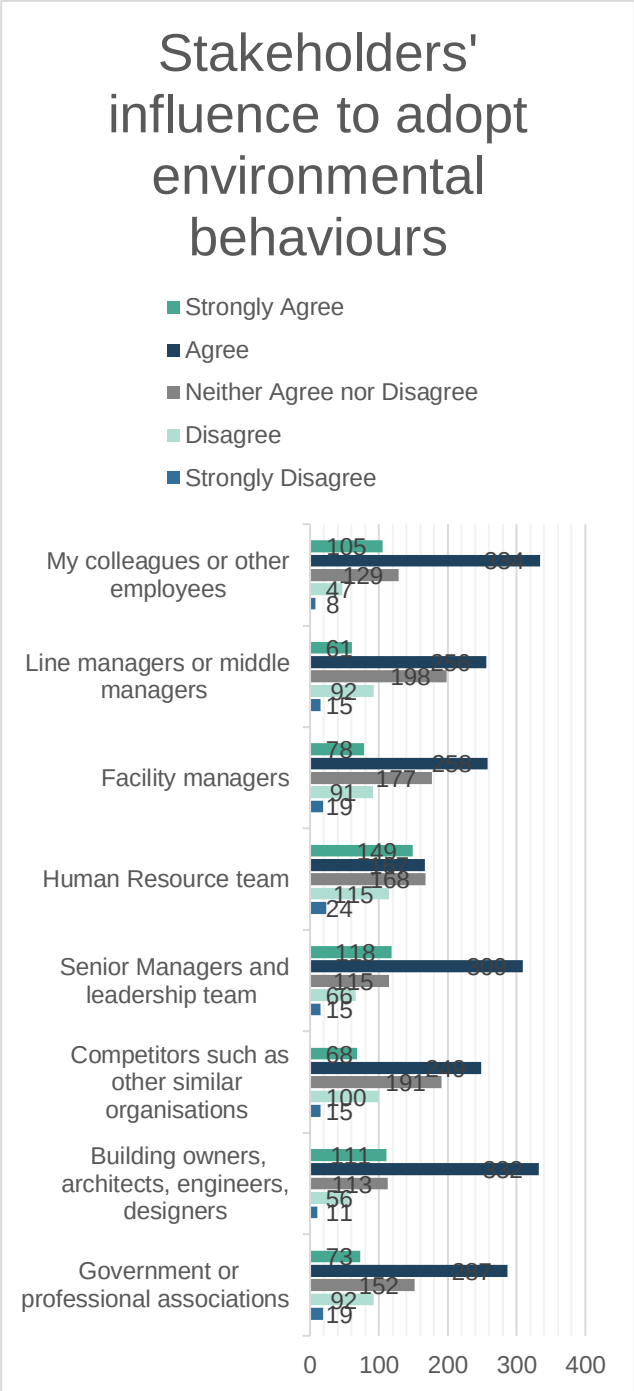
Attitudes of occupants

The occupants and the management who took part in the survey are in in favour of appropriate environmental behaviour in the high performance low carbon buildings. This can be achieved by tenants' support to involve the occupants' to incorporate workplace practices that can improve the overall building performance. The survey respondents identified that the building design reflects a sense of identity to promote the occupants environmental attitudes and performance. The individual awareness of the buildings' sustainable features will be more likely to adopt right approach to use the design features appropriately as part of business strategy. When the tenants does not perceive that the design feature of the buildings will influence the occupants, which directly influence their business, they will less likely to drive the tenants to a sustainability direction.



Subjective Norm-Stakeholders influence

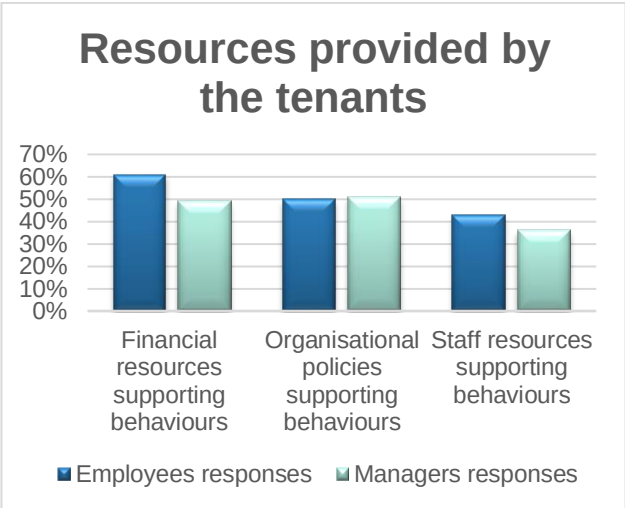
The study found that expected social norms have a positive relation with environmental behaviours in high performance low carbon buildings. The social norms are social influences impacting on individual's intention to perform or not to perform (Ajzen and Fishbein, 1980). The subjective norms in this context are determined by the influence of external stakeholders such as government, building owner, architects, designers, competitors as well as internal stakeholders such as senior managers, HR managers, facility managers, line managers and the colleagues. The study also highlighted senior management's perception of whether key stakeholders can be critical for the occupants to adopt environmental behaviours in the workplaces located in high performance low carbon buildings. These internal stakeholders can also influence many aspects of occupant's green behaviours and attract future employees.



Cognitive factors

The next group of factors are concerned with cognitive factors which comprise perceived behavioural control. In the context of buildings, the study found that the most important predictor of the intention to improve appropriate behaviour required in high performance low carbon buildings is perceived behavioural control. Perceived behavioural control (PBC) is defined as the extent to which organisations have complete control over their adoption behaviour. There are many who suggest that organisational readiness is important in adoption behaviour, such as having organisational function to support behaviours, feedback, workplace diversity.

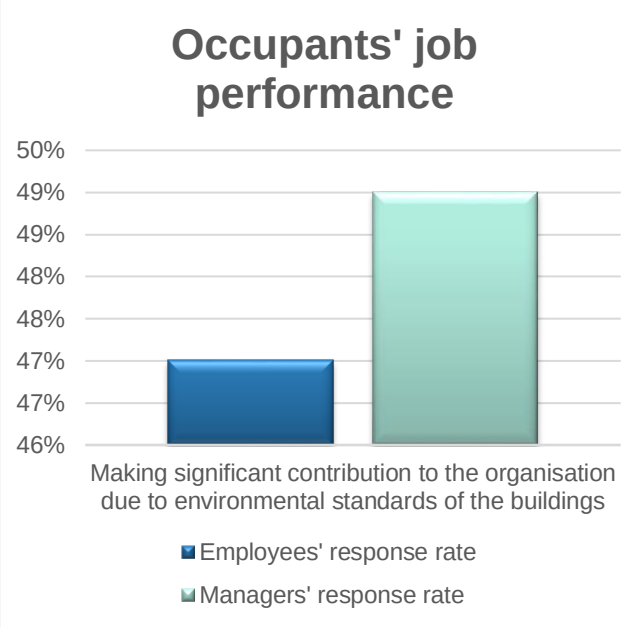
Organisational readiness can be viewed as operational readiness, financial readiness, staffing readiness, technical readiness and knowledge readiness. Green HR initiatives can be viewed as radical changes within an organisation. They also require significant time and resources to put them into practice. Introducing organisational initiatives from the tenants can incur substantial financial and non-financial costs. For this reason, in the absence of slack financial resources or work force, senior managers may perceive their organisation as lacking control over organisational initiative adoption. Thus, the level of financial and non-financial resources can improve tenants' decisions to include organisational initiatives that can make occupants to behave according to building needs.



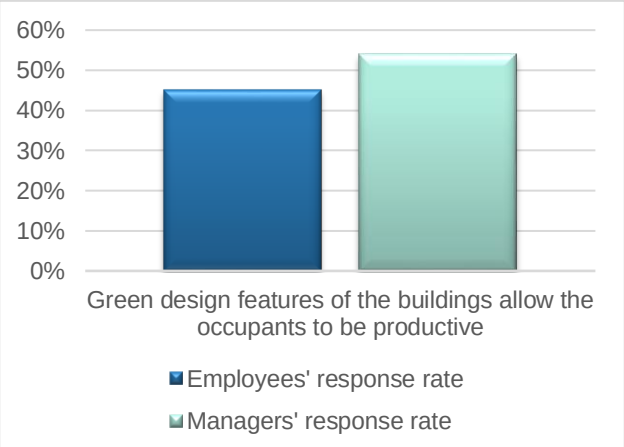
Performance Metrics

Economic Performance

The findings from this survey shows some relationship between environmental features of building design and occupants' job performance. From the survey, more than 45% of managers and employees think that the environmental behaviour of the employees make employees to take ownership of their job. The occupants can contribute to the overall performance of the buildings due to the design facilities provided by such high performance low carbon buildings. Additionally, although such benefits of employees' own job performance may not contribute directly to their actual work effectiveness or efficiency, the tenants may factor in such contributions when rating their employees' job performance. Design features that facilitates task accomplishment also bolster occupants' productivity.



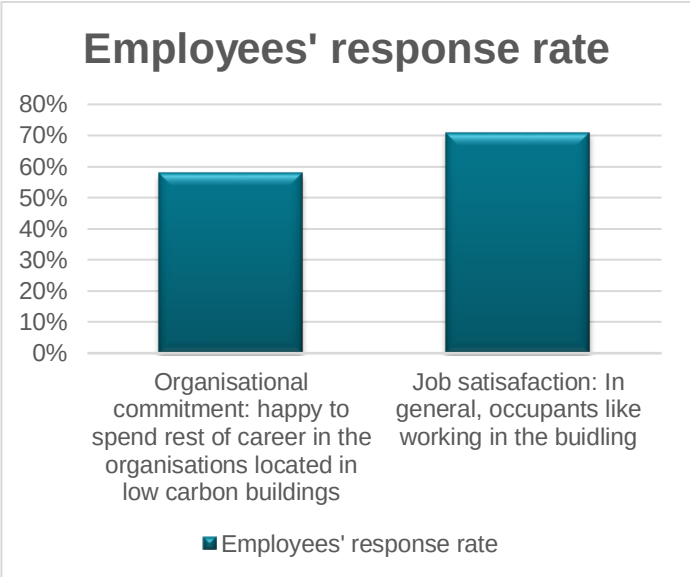
Apart from the commonly design features built into the high performance low carbon buildings, other green design attributes such as environmental controllability, recycling options can often affect the stress reduction of the occupants. This survey finds that occupants working in offices with more green design attributes will report greater work engagement such as productivity than those working in offices with fewer green designs attributes. More than 40% of the employees and managers agrees that green design features of the buildings allows the occupants to be productive.



Employee Performance

The survey findings revealed the relationship of social wellbeing such as job satisfaction and job commitment due to the environmental features of the high performance low carbon buildings. Organisational commitment is the degree of psychological identification to an organisation. Occupants with strong affective organisational commitment remain because they want to as they have a positive job satisfaction due to environmental features of the office space. This organisational commitment of the occupants is increased due to the job enrichment and opportunities provided by the tenants. The response from the survey correlates the green design attributes of the physical environment with the organisational commitment. The organisational commitment here means that how long an employee's stays with the organisation.

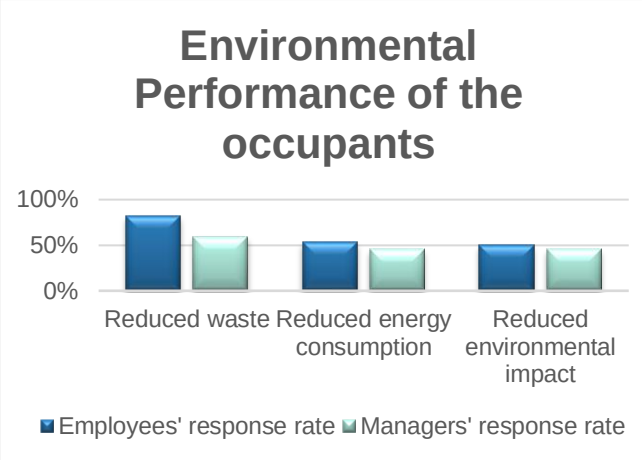
This study demonstrates the tenants' practices helps to align environmental values and enhances the motivation and greater participation from the occupants. Increased commitment is likely to result in the occupants showing discretionary effort in maintaining the green features of these high performance low carbon buildings. The tenants' practices is related to satisfaction. The opportunities provided to the occupants to understand the design features of the buildings will increase satisfaction, as occupants perceive that they are well suited to the task. With greater information sharing, the occupants are more satisfied with their work. The occupants who are satisfied will be more motivated to engage in discretionary behaviours will ultimately assist the tenant in achieving better performance results.

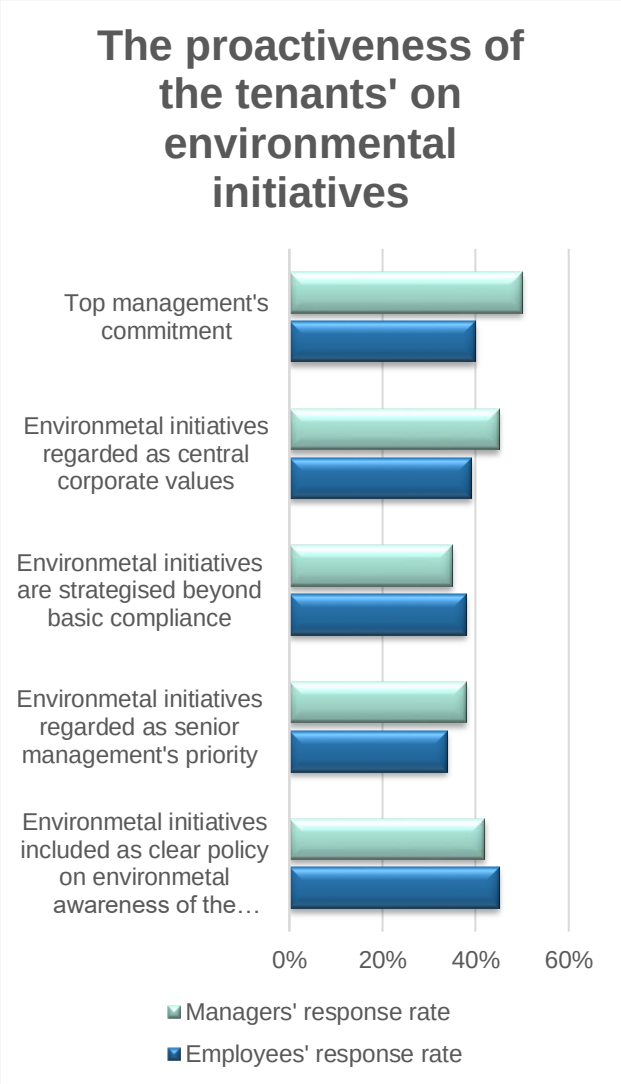


Environmental Performance

The survey found how the tenants can increase their environmental influence when occupants take initiative in their job in favour of the environment. Occupants are involved at their own level in helping the tenants become greener. The findings acknowledges the role played by the occupants in preventing the negative impact of their actions towards environment including reducing waste and energy consumption. Such behaviours at work acts as a key explanatory mechanism, in the relationship between the tenants' workplace practices, and environmental performance. In additional to the overall environmental performance of occupants working inside high performance low carbon buildings, successful implementation of green strategy enhances the environmental commitment of the tenants. Proactive tenants internalise environmental challenges and

optimize their processes to satisfy the business demand and handle environmental issues of the building or their workplace. When the tenants demonstrate strong environmental performance, they may be more likely to deploy and exploit their resources and capabilities toward the implementation of green strategies.



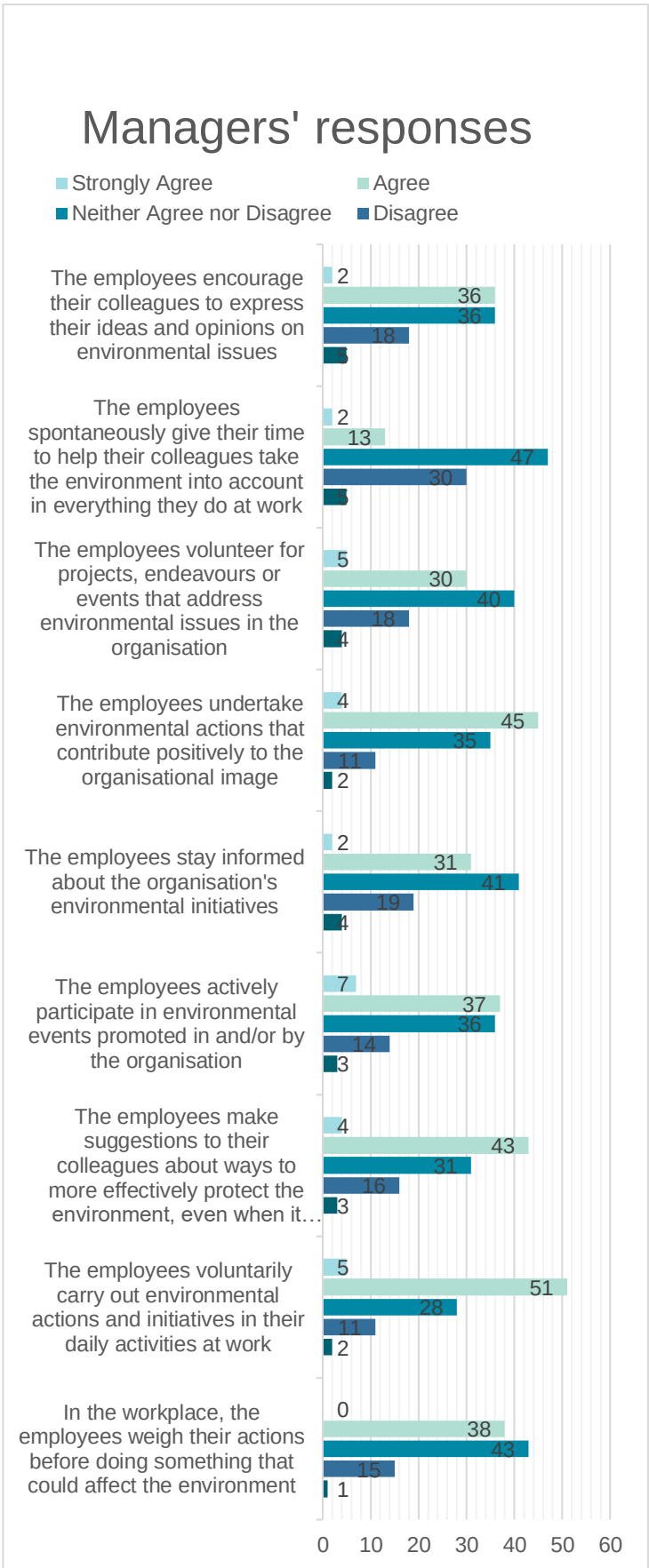


Workplace behaviours

First, with the development of environmental behaviours in the workplace have become essential to reduce carbon emission in the workplace. Second, the employee's willingness to engage in environmental behaviours such understanding the design features of high performance low carbon buildings supports environmental management activities of the building. By demonstrating spontaneous behaviours, occupants can also play an important part in the development of environmental innovations within the design of the workplace

Employees are generally key players in the development of lean and green practices that help improve both operational and environmental performance of the buildings. The management process is helpful to manage competency in terms of undertaking the green practices in the buildings voluntarily. In addition, each individual on job contributes to the awareness of building design among the colleagues. Often these decisions concern discretionary behaviours contributes to the image of the tenant organisation.


Employees' responses
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
Strongly Disagree
I encourage my colleagues to express their ideas and opinions on environmental issues
37
256
222
76
32
I spontaneously give my time to help my colleagues take the environment into account in everything they do at work
29
177
215
166
36
I volunteer for projects, endeavours or events that address environmental issues in my organisation
34
148
249
155
37
I undertake environmental actions that contribute positively to my organisational image
41
304
177
82
19
I stay informed about my organisation's environmental initiatives
29
285
213
77
19
I actively participate in environmental events organised in and/or by my organisation
34
208
236
118
27
I make suggestions to my colleagues about ways to more effectively protect the environment, even when it is not my direct responsibility
36
246
195
126
20
I voluntarily carry out environmental actions and initiatives in my daily activities at work
120
317
132
39
15
In my work, I weigh my actions before doing something that could affect the environment
88
393
98
34
10
0
100
200
300
400


Managers' responses
Strongly Agree
Agree
Neither Agree nor Disagree
Disagree
The employees encourage their colleagues to express their ideas and opinions on environmental issues
2
36
36
18
5
The employees spontaneously give their time to help their colleagues take the environment into account in everything they do at work
2
13
47
30
5
The employees volunteer for projects, endeavours or events that address environmental issues in the organisation
5
30
40
18
4
The employees undertake environmental actions that contribute positively to the organisational image
4
45
35
11
2
The employees stay informed about the organisation's environmental initiatives
2
31
41
19
4
The employees actively participate in environmental events promoted in and/or by the organisation
7
37
36
14
3
The employees make suggestions to their colleagues about ways to more effectively protect the environment, even when it…
4
43
31
16
3
The employees voluntarily carry out environmental actions and initiatives in their daily activities at work
5
51
28
11
2
In the workplace, the employees weigh their actions before doing something that could affect the environment
0
38
43
15
1
0
10
20
30
40
50
60

Workplace practices

From the survey, it is revealed that around 30% of the occupants are unaware of the design potential of their workplace. This study revealed that using some key organisational practices can encourage environmental behaviours in the occupants. However, findings also indicated that organizations are not using organisational practices to a great extent overall. This implies that over one-third of tenant organizations were either not using this method at all, or using it rarely. Thus, organizations could use organisational practices more actively to promote environmental behaviour in high performance low carbon office buildings. Most notably in relation to creating internal awareness, training courses encouraging environmental behaviour, encouragement by senior management, strategies included in organisations' vision and mission statement team. These management responders also included recruitment and induction programs to encourage such behaviours. Managers' influence may be particularly crucial because leaders have the scope and visibility to ensure that the same environmental messages reach a large number of employees. Furthermore, tenant's involvement of this nature may become the starting point for other methods concerning employee empowerment, including green teams, and awareness-raising campaigns due to an increase in innovation elicited by transformational leadership.

Framework

Of course, buildings are complex and can require a high level of commitment to understand, and connecting physical spaces and occupants role in the enhancing the performance can appear difficult. In this study, the researchers have tried to distil information and make it actionable from the tenants' side. The framework adapted from Theory of Planned Behaviour (Ajzen and Fishbein, 1980) is one way that tenant organisations can begin to take an integrated approach, with an emphasis on making headline assessments of buildings using an adequate but not overwhelming number of data points. This method could be used, in part or in whole, by all kinds of actors in the industry who want to understand the issue better and get the best from their buildings. The framework has three major components, which are taken in turn below.

The antecedents of adopting effective workplace practices is predicted by the interaction of three factors: (1) attitudes; (2) subjective norms; and (3) perceived behavioural control. The design related behaviours can not only impact the individual performance such as productivity or job satisfaction but based on this framework, the firm level performance outcomes such as building overall environmental performance and tenant's ethical image can be achieved. Further, occupants' perceptions, which are influenced by stakeholders (subjective norms), influence their decision to adopt specific green practices. One category is resource readiness, which represents a facet of perceived control. That is, when occupants perceive that they have the 'right' resources (both financial and nonfinancial) their perceived control over the adoption of practices will be increased.

At the start of these key findings of the survey, we highlighted the importance of workplace practices for making occupants understand the design utility and features of the buildings so that they are aware to use it effectively. Through our research process, it became clear that there was no 'magic formula' for 'proving' the business case. What we have done is demonstrate quite clearly the physical office environment has an impact on the health, wellbeing and productivity of occupants. From the survey, it is clear that there are tools available to help make the tenant organisation create an effective process where the building can function the way it is meant to be and creating positive impact on the occupants and the buildings. There is clearly an opportunity for tenant organisations to begin to think differently and use their physical premises for competitive gain. This is true from investors' right through to occupiers, whether tenants are trying to command a higher price for a high performing building or looking to take the kind of space needed to help drive business success. The organisational practices we suggest could be used, in part or in whole, by all kinds of actors in the industry who want to understand the issue better and get the best from their buildings. The forward-thinking sustainability professional could be viewed as having a role in helping to get all three sets of actors above to start thinking and working together. There is even an argument for suggesting health, wellbeing and productivity should be synonymous with sustainability.

Best Practices for tenant organisations for greater building awareness among occupant employees

This research outlines a number of important ways in which tenants practices at organisational and individual level can support the buildings' environmental, employee and economic performance and suggests that aspects of the employee life cycle are crucial in supporting the initiatives associated with a high performance low carbon buildings.

Practices that influences at the organisational level	Practices that influences at an individual level	
Manager involvement	Performance appraisal	Education and training
Organisational Culture	Rewarding environmental behaviours	Recruitment of environmentally motivated staff

Recruitment of environmentally motivated staff

First, individuals committed to the environment should initially be selected into the organization, and, second, employees should be evaluated based on environment-related criteria. This is particularly easy for tenants whose core business is sustainability. However, for other organisations, candidates with similar technical profile can be assessed by incorporating personality factors into green recruitment, based on earlier work that linked openness, agreeableness and conscientiousness to green behaviours. With an increasing number of 'green jobs' and green tasks being added to existing roles, emphasizing environmental aspects within job descriptions and person specifications has been another strategy for green recruitment as well as using interviews to draw out candidate's environmental knowledge, values and beliefs. Not only can recruitment practices cultivate a greener workforce, the tenant organizations adopting green practices can benefit from attracting a wider pool of high-quality candidates.

Performance appraisal

Using environmental management performance indicators in appraisal is a further management tool. Although many EMSs do not stress the importance of appraisal feedback in relation to environmental behaviour. This study suggests that feeding back the impact and effectiveness of environmental efforts through metrics and appraisal processes is key in facilitating environmental performance of the building. The key benefit of including environmental performance indicators within performance management systems is

that occupant employees become accountable for environmental management of the building.

Rewarding environmental behaviours

Reward systems should be designed to reflect tenant organisations' commitment to environmental performance while reinforcing and motivating employee occupants' environmental behaviours. The rewards themselves can be monetary (e.g. bonuses, tax exemptions, profit shares) or nonmonetary (e.g. recognition, praise) depending on the motivations of the employees as typically, people are motivated by different 'carrots' and 'sticks'. This study found from the survey that social rewards, monetary rewards and, public rewards can be effective in reducing energy use if

punishments or negative reinforcements for failing to make environmental improvements (e.g. warnings, suspensions) are too harsh. In such cases, occupants may withdraw from environmental management or fail to disclose environmental problems, whereas if rewards are too 'weak' they may fail to motivate employee behaviour. Reward systems should therefore be well-designed and individually relevant to create more awareness of the design features of high performance and low carbon buildings.

Education and training

Appropriate training is required to make the occupants understand the environmental standards the buildings they work. Successful implementation demands that employees receive information about the standards through introductory training sessions. Through the provision of education and training, employees can become aware of the need for pro-environmental action in the first place, become equipped with the key knowledge and skills needed to carry out environmental behaviours (in these buildings and become empowered and motivated to participate in environmental initiatives by the tenants. The findings from this study demonstrated that environmental training and education aligns with cultivating a culture where employees feel accountable for performance outcomes of the buildings. This study suggests that the training should also focus on changing attitudes and emotional involvement toward environmental goal.

Employee empowerment

The introduction of any new system will be more successful if employees are treated as key stakeholders in the organization. Reflecting traditional change management research, environmental initiatives that are implemented by tenant organisation but without employee involvement are likely to be less successful. A lack of public and professional education about high performance and low carbon buildings and their benefits is hampering the greening of commercial buildings in Australia. This study have found that employee involvement in management of the building is related to improved environmental performance of the buildings as well an individual environmental performance. Individual environmental performance has links to improved satisfaction and overall firm performance. Thus, the study highlights to engage, motivate and empower the employee occupants to come up with ideas for implementing building process in more effective manner.

There are a number of methods reported in this study that can increase employees' involvement toward environmental management of the buildings. For example, introducing newsletters, suggestion schemes and problem solving groups, identifying low carbon or environmental champions and setting up 'green teams' to motivate employees to be involved in environmental improvement efforts.

Manager involvement

The importance of top management commitment in driving forward environmental sustainability is well recognized within this study. This stems from management's ability to direct corporate strategy along with organizational policies, initiatives, programs and reward systems. Top management subsequently provide the framework for environmental improvement including the success of a high performance low carbon buildings.

Organisational Culture,

A key contributing factor is cultivating a corporate culture that supports environmental improvement, i.e. ensuring that the organization's underlying values and assumptions are in line with environmental sustainability and employees are given the freedom to make environmental improvements at their workplaces. Management can contribute toward this cultural development by not only communicating positive environmental values but also role modelling environmental behaviours themselves.

Implications

This study provides implications for research and practice. First, this study contributes to occupants' green adoption behaviour in high performance low carbon buildings. This study enhances our understanding of key factors that can drive tenant organisations to become greener in high performance low carbon buildings.

This study suggests, attitudes can inspire behaviour and norms can be influenced to make environmental activities more common and socially accepted in these buildings. The role of internal stakeholders, such as management and employees, can influence organisational direction towards green practice. From the top-down approach, senior management can integrate green practices as a part of HR strategy. Senior management can drive and increase employees' commitment to, and awareness of, the issue of environmental sustainability through green strategy. From the bottom-up approach, the enactors of green workplace behaviours are employees' occupants.

Effective green initiatives should be encouraged from employees with top management support. Employees can drive the greener workplace by initiating green activities or acting as green champions to support green initiatives in the office environment. Employee occupants can be viewed as green capital and drive organisations to formally adopt and benefit from green practices in these buildings. The maintenance of these building can contribute to the overall functioning of these buildings. The tenants and owners can liaise with the architects and engineers for a feedback loop about the problems, they face and in return they can get advice on how to make the best use of the buildings. The transparent communication between the stakeholders can contribute to the overall environmental performance of the buildings. The process can built strong relationship among the different actors within the building design which can impact the wellbeing and productivity of the occupants.

Key Findings aligned to CRC Milestones

This report communicates and engages with the existing and future stakeholders of high performance low carbon buildings about the opportunities on how tenants can influence occupants green behaviours in these buildings. The systematic review is a dissemination of evidence-based research encouraging low carbon practices to become mainstream. The findings from the survey will support various audiences based on expectations to involve occupants' behaviour as critical aspect of high performance low carbon buildings. The report highlights outcomes for wider mainstream implementation over time to sustainable buildings construction and maintenance. The intention is to promote engagement with and between government, industry and communities about CRCLCL opportunities, investment in effective communication between different stakeholders of sustainable buildings, including fit-for-purpose solutions through business cases and implementation strategies that account for available resources and expertise (human and financial).

As indicated from this study, key organisational practices can influence occupants' behaviour in these buildings; therefore, the outcomes of this study align with the outcomes of other programs that will support the development of awareness education programs in buildings. The key findings can help stakeholders to identify and prioritise opportunities as well as expectations based on individual project. Engagement with appropriate experts who use proven techniques is important. The outcomes would potentially add important social-cultural dimension to analysis of energy consumption behaviours to shape economic outcomes such as productivity and social outcomes such as wellbeing, including categories of sociability, liveability, comfort, control, competencies, and awareness. The opportunities require whole systems thinking and paradigm shift to determine the human centric design priorities assessed against the costs and benefits.

Potential Future Priority Research Areas

The study outcomes indicate the need for further research to remove barriers and develop new methods to support behaviour building programs in these high performance low carbon buildings:

- This study highlights the importance of occupant's behaviours and perceptions towards adopting green practices in high performance and low carbon buildings. There is a need to develop more standardised methods and measures to assess occupants' perceptions, similar to the protocols available for most other physical measurements such as actual indoor air quality, ventilation rates, thermal quality, and acoustic
- The study explores the relationship between occupants' energy behaviours and different categories of performance in high performance low carbon buildings. Future studies can explore the communication of environmental performance of these buildings with employee performance such as wellbeing, job satisfaction and commitment as well as with economic performance such as productivity.
- This research focussed on commercial office buildings. More research that is comprehensive is needed to investigate the generalizability of these findings in other work settings such as hospitals, manufacturing industries, retail.
- This is a common problem for self-report questionnaires is although self-report data have been shown to be valid in the context of environmental behaviour when objective and subjective data were compared nevertheless, we recommend that future survey studies should aim to collect some objective data, such as energy and resource usage and waste.

Conclusion

High performance low carbon buildings and workplaces have the basics right from improving overall energy efficiency of the building. However, at the same time, there are specific areas which need fine tuning in order for green workplace environments to operate at their fullest potential. Many organisations increasingly adopt green practices into their business operations. Therefore, scholars and practitioners concerned about environment-related issues should be aware of drivers and mechanisms of the adoption process.

Definitely, from the systematic review, this study found that embedding tenant level initiatives is possible to improve performance of the occupants in high performance low carbon buildings. The overall outputs of the papers studied under the systematic review conducted highlights the potential areas that can provide direct engagement with the building design through key organisational practices. The outcomes are beneficial for the organisation at leadership as well as at employee level. This could improve the organisational image, its culture, enhancing employees' satisfaction levels, their commitment towards the organisation. The studies also highlights the management's ability to improve the overall building performance can be achieved by emphasizing on practices such as providing more engagement, flexibility to the workers, developing training and awareness programs about the building and communicating through critical feedback from the occupants.

The post occupancy evaluation in this study explored the relationship between the end users of the building and the performance. The study revealed the social factors consisting of social and personal norms crucial for occupants' behaviours in buildings. Personal norms represent one's own beliefs and attitudes on how to act. Social norms such as the influence from external stakeholders and internal stakeholder can influence the overall behaviour. Lastly, the occupants behaving in certain ways largely depends on the nature of the resources provided to them. Findings from this survey focussed the tenants' plan and intentions to improve productivity and wellbeing in high performance low carbon buildings.

We cannot understand this process at the firm level without some understanding of the key decision-makers who influence environmental management adoption in high performance low carbon buildings. Such an understanding might help tenant organisations and managers transform their organisational policies and practices into economically and ecologically sustainable ones. We are acutely aware that the best business cases for high performance low carbon buildings can only be possible if the solutions are personal and not hypothetical. What we see as a low cost route to potential better building and organisational performance our aim is not to argue a general business case. Instead, we want to make an awareness of a prime, currently missed opportunity in real estate and give specific steps to understand what that means to all the stakeholders of high performance low carbon building design. This is not an opportunity that requires a large commitment or is not a high risk strategy or an opportunity for someone else. It is, or should be, a core business strategy. This is a compelling argument and has certainly helped to move the agenda forward, but by and large this aspect has so far failed to engender a lot of action. Surely, part of this is because people see the numbers before undertaking any organisational changes.

This report is an attempt to remedy this situation. Studies of human nature tell us that people are risk averse, and while unwilling to gamble for a gain are highly reactive to loss. This kind of thinking has pervaded the industry regarding energy, where companies have been reluctant to act based on a 'premium' but are highly sensitive to depreciation for perceived poor performance. So talking about gains, however big, is often not as effective as talking about small losses. We think that these principles may begin to play out in the health, wellbeing and productivity agenda as the topic goes more mainstream and as our ability to measure performance in these areas increases. The business case for healthy buildings has always been based on what occupants can gain, but increasingly (as with energy) the most important question is what do owners and tenants stand to lose?

There is an important difference between energy and health that cannot be overlooked and certainly affects the business case. The health, wellbeing and productivity agenda is powerful because it impacts everyone, not just those with an interest in sustainability. It appeals to workers and management alike by promising more (health, wellbeing, profit) and not mandating less (energy, resource use, etc.). From a business perspective, engaging with this issue can be a very potent and attractive strategy. Health, wellbeing and productivity are on the cusp of being better understood and applied in the industry, and advances in technology will bring that even closer. Is it too far-fetched to think that in the not-too-distant future, cheap wearable and portable technology may allow occupier-driven 'big data' to compare office environments at scale? Engaging with this agenda early and carefully promises significant benefits for companies who choose to stay ahead of the curve.

We believe that tenant organisations need to implement more systematic practices, to orient the attitudes and behaviours of the occupants according to the sustainability agenda of the buildings. The organisations already has lot of information that could yield important immediate improvement strategies for their two biggest expenses – people and places, and the relationship between the two. This is less difficult than it seems. It requires a different way of thinking and working rather than a great deal of extra, expensive data capture. The sweet spot in this agenda is where the circles on buildings (FM), people (HR) and finance overlap, and yet so few businesses take advantage of this rich space.

This situation represents a huge missed opportunity. If we better understand the relationship between the office, people and organisational performance, the potential for practical application is significant. This includes due diligence on new space, rent review on existing space, fit-out guidance on refurbished space, and so on. A

better understanding of how buildings impact people should drive improvements in the workspace, which may be one of the most important business decisions to be made.

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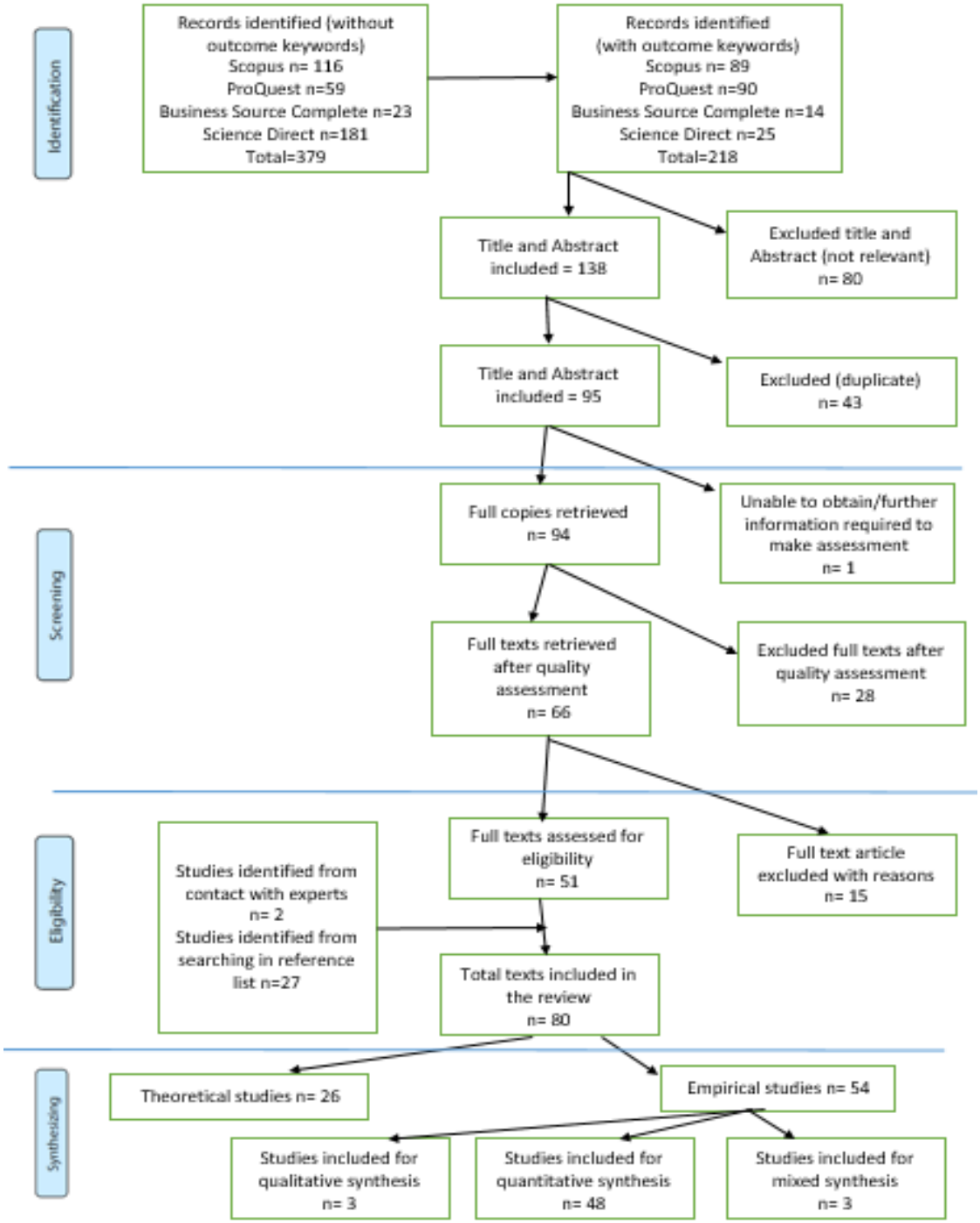
Appendices

Appendix 1: The Systematic Literature Review



Appendix 2: Employees Survey Data

Employees n=623

	Employees	Employees		Employees	Employees
	Frequency	Percentage		Frequency	Percentage
Gender			Green buildings		
Male	285	45.75	Yes	475	76.24
Female	286	45.91	No	144	23.11
Age group			Green Organisation		
15-19	1	0.16	Yes	434	69.66
20-24	29	4.65	No	185	29.70
25-29	106	17.01	Duration of working in the building		
30-34	122	19.58	A year or more	445	71.43
35-39	114	18.30	Less than a year	174	27.93
40-44	80	12.84	Working hours in a day		
45-49	77	12.36	1-2 hours	2	0.32
50-54	44	7.06	3-4 hours	9	1.44
Older than 55 years	50	8.03	5 or more hours	612	98.23
Position			Working days in a week		
Managerial	33	5.30	Less than three days	16	2.57
Professional	439	70.47	Three days	53	8.51
Support staff	99	15.89	Four days	83	13.32
Clerical	36	5.78	Five days	435	69.82
Lifestyle			More than Five days	34	5.46
Very Active	165	26.48	Do you regularly work in the office		
Somewhat active	371	59.55	Yes	109	17.50
Sedentary	84	13.48	No	510	81.86

Appendix 3: Managers Survey Data

Manager n=97

	Employees	Employees		Employees	Employees
	Frequency	Percentage		Frequency	Percentage
Gender			Green buildings		
Male	56	57.73	Yes	82	84.54
Female	32	32.99	No	15	15.46
Age group			Green Organisation		
20-24	2	2.06	Yes	75	77.32
25-29	2	2.06	No	22	22.68
30-34	8	8.25	Duration of working in the building		
35-39	23	23.71	A year or more	67	69.07
40-44	21	21.65	Less than a year	30	30.93
45-49	19	19.59	Working hours in a day		
50-54	10	10.31	3-4 hours	1	1.03
Older than 55 years	12	12.37	5 or more hours	96	98.97
Position			Working days in a week		
Managerial	58	59.79	Less than three days	3	3.09
Professional	32	32.99	Three days	7	7.22
Support staff	6	6.19	Four days	12	12.37
Lifestyle			Five days	71	73.20
Very Active	19	19.59	More than five days	4	4.12
Somewhat active	66	68.04	Do you regularly work in the office		
Sedentary	11	11.34	Yes	19	19.59
			No	78	80.41