UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Workplace design and perceived health status of office workers – a salutogenic perspective

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Certificate of Original Authorship

I, Kirsten Brown declare that this thesis, is submitted in fulfilment of the requirements for the award of PhD in the Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Abstract

Almost a third of Australia's working population is employed in sedentary indoor office environments (Australian Bureau of Statistics 2017-2018), putting them at increased risk of cardiovascular disease and cancer, as well as metabolic, musculoskeletal and psychiatric disorders (Owen et al. 2010; van der Ploeg et al. 2012). This study used a 'salutogenic' approach to examine factors contributing to perceived health rather than disease, particularly the relationship between office workers' health and workplace design. With a holistic approach, health-promotive offices incorporate elements and strategies that enable physical activity and promote health positive outcomes.

This research used a mixed-methods convergent parallel case study design to examine the workplace elements that impacted the perceived health of office workers occupying two buildings (Sites A and B), who later relocated to a single new building (Site C). The influence of workplace elements (including workpoint, office layout, indoor environmental quality and organisational policy) on workers' perceived health was explored through semi-structured interviews and survey questionnaires with workers at all sites before and after relocation. Site analyses were also conducted. Key informants involved in the project design were interviewed about the workplaces and approach to occupant health. Qualitative interview data were analysed using template analysis. Survey respondents were recruited from 1,200 employees and invited to complete a 66-item survey (including SF-12) to determine the impact and importance of workplace elements on perceived health. The quantitative survey data were analysed using SPSS software.

Nine key informants were interviewed at Sites A and B and four at site C. Interviews revealed shortcomings in current practice, including a lack of communication with employees and consideration of health promotion that limited the potential positive impact of the physical environment.

The survey questionnaire was distributed to all employees, and 515 useable surveys were returned. Results show that the interior elements such as the individual workpoint, access to daylight, and access to stairs to support health and enable physical activity should be prioritised to maximise positive health impacts on occupants. Flexibility was consistently highly rated for its positive impact on occupant health.

To avoid a fragmented approach to workplace planning, designers must incorporate workers' views alongside health experts'. This will reframe current design practice to ensure holistic approaches and develop health-promoting workplaces and policies that embrace positive health and well-being. This multi-professional and collaborative approach will ensure the co-design of office environments responsive to occupants' health needs. The inclusion of workplace features that have the greatest positive impact on worker's health,

such as access to daylight and stairs, must be prioritised. This study has highlighted the importance of integrated workplace policies such as choice of work location and timing. Finally, there is a need for a standard approach to measuring occupant health in the office environment to generate data to ensure future evidence-based solutions.

A proactive multi-disciplinary salutogenic approach incorporating both policy-based and physical elements to workplace design will advance current practice by placing worker health and well-being at the centre of decision-making.

Chapter 1 Introduction

Background

Almost a third of the Australian working population spends their workdays indoors – relatively sedentary – in office environments that may not enable, support, or promote their health and well-being. During 2017-2018, the most common occupations in Australia were professionals (18.5%) and clerical and administrative workers (11.4%), accounting for almost a third of all workers based in an indoor office environment (Australian Bureau of Statistics 2017-2018). Long periods of prolonged sitting are associated with physical inactivity (Sugiyama et al. 2020), and office workers spend up to 75% of their day seated (Hadgraft et al. 2016; Parry & Straker 2013, p. 604). Time spent sitting increases the risk of dying; sitting more than eight to eleven hours a day increases mortality over three years by 15% compared to those who sit less than four hours per day (van der Ploeg et al. 2012). As the number of indoor sedentary workers grows, so does individual- and community-level sedentary-related health impacts. In 2011, physical inactivity was the fourth highest contributor (5%) to the total burden of disease and injury in Australia (Australian Institute of Health and Welfare 2016).

The health effects of sedentary occupations were described in the early-1960s. A seminal study of over 4,500 London bus drivers and conductors in 1961 (Heady, Morris & Kagan 1961) showed that drivers who spent up to 90% of their day sitting were twice as likely to have coronary artery disease as the conductors who spent the day standing and walking around the bus. Communication tools such as the typewriter became commonplace, and employed women were required to sit for extended periods typing documents (Kroemer 2001). Changing workplace demands led to the early exploration of office ergonomics and supporting people with administrative and management tasks (Kroemer 2017). The term ‘ergonomics’ was first used in Poland in the late-1800s and encompassed many disciplines associated with studying humans, from anthropology to sociology (Hedge 2017). Ergonomics can be defined as ‘the study of human characteristics for the appropriate design of the living and work environment’ (Kroemer 2017, p. 227). Ergonomics has adapted to changing workplaces as new roles are created in response to technological and economic change.

In addition to sedentarism, office employees’ health is impacted by other features of office work and the office environment, ranging from the broader indoor environment to the individual work point (Aristizabal et al. 2019; Hedge 2017). Elements in the indoor environment that are important to office workers' health include lighting, daylight, noise, spatial layout, office furniture, and physical features of the workplace (Colenberg, Jylhä & Arkesteijn 2020). While multiple workplace factors influence health, the density and layout

of open-plan offices have received attention for their influence on productivity and individual satisfaction (Vischer 2007). Environmental comfort is of three hierarchically-related types: physical, functional and psychological (Vischer 2007). Physical comfort addresses basic human needs such as hygiene, safety and accessibility. Functional comfort is ergonomic support for specific tasks, such as appropriate settings for work tasks, correct lighting and ergonomic support for desk-based work. Psychological comfort is a higher-order comfort type, achieved by a sense of belonging, choice and perceived workspace 'ownership' (Vischer 2007).

Approaches to office workplace design and implementation in Australia have changed considerably over the past two decades. Current approaches are now more user-centred and recognise occupants' health and well-being needs (Candido et al. 2016). One of the early examples of collecting feedback from the user or occupant is the post-occupancy evaluation (POE) studies described by Heerwagen et al. (1995). Heerwagen et al. (1995) described how the office workplace consists of many elements that impact occupant health, ranging from the desk to broader environmental conditions such as lighting, air quality and spatial layout. The authors concluded that all of these elements required investigation to better understand their relative impact. While there are many examples of thriving and effective workplaces, there remains a pressing need to focus priorities on including workers' health.

Despite increased awareness of health-impacting factors, design approaches remain centred on risk prevention, disease prevention and risk minimisation (Roskams & Haynes 2019). However, momentum is growing for more proactive approaches that recognise the workplaces' potential to improve office workers' health outcomes. Focusing on positive health and well-being rather than disease prevention or treatment has been developed into a conceptual model, 'Salutogenesis', by Aaron Antonovsky in 1979 (Mittlemark 2017; Roskams & Haynes 2019). The concept of salutogenesis has been used globally, including by the European Health Promotion Indicator Development (EUHPID) project (European Network for Workplace Health Promotion 1997). The EUHPID posits that projects should be assessed on factors that promote and build health.

Adopting a 'salutogenic' approach to workplace design requires a multi-disciplinary, positive and proactive approach to problem-solving that improves occupants' health outcomes (Bauer et al. 2019). A central element of a salutogenic approach is health promotion. While the built environment can impact occupants' health, promoting health in other ways will enhance workplace interventions (Goetzel & Ozmlnkowski 2008). The World Health Organization (WHO) has identified the workplace as a priority setting for health promotion in the 21st century, as it is an ideal setting for promoting and implementing positive health activities (Page & Nilsson 2017). A health-promoting framework must consider the links

between individuals, their work and the workplace environment (Motalebi (2018). Therefore, the workplace could be the ideal environment for establishing and promoting positive health practices for both working and home life.

In 2020, the COVID-19 pandemic led to a more distributed workforce. Many professionals began working outside the traditional office environment, increasing the need for health promotion as a critical element in promoting workers' health outcomes. This global disruption may create lasting change in how we design workplaces and respond to the health needs of office workers (Johnson 2020; Öste 2020).

Organisations recognise the potential impact of the workplace environment on their employees' health and productivity. Failure to address employee health can increase absenteeism and 'presenteeism' (workers performing poorly and below their abilities) which have significant economic impacts (Australian Industry Group 2015). In 2015, the annual absenteeism rate for non-manual labour was 2.86% (Australian Industry Group 2015). The economic cost of absenteeism is considerable: at AUD $578 per person per day, absenteeism cost the Australian economy $44.6 billion in the year ending 30 June 2015 (Australian Industry Group 2015, p. 5). Presenteeism affects productivity and employee well-being (Brown et al. (2011) and may also impact health. To address absenteeism and presenteeism, the relationship between the office workplace and occupants' health should be further investigated (Colenberg, Jylhä & Arkesteijn 2020).

Office users' responses to the interior environment are dynamic, interactive and unique to individuals (Jamrozik et al. 2018; Zimring et al. 2005). Therefore, understanding office workers' perceptions and preferences may provide a basis for practice when designing and creating workplaces (Bluyssen et al. 2011; Roskams & Haynes 2019). Indoor environments are diverse, so relationships between each unique environment and occupant responses may vary significantly (Stokols (1992). For example, an office located in a base-building with an older ventilation system or limited daylight access may negatively impact occupants' experience and health outcomes (Boubekri et al. 2014; Das 2015; Fostervold & Nersveen 2008; Mills, Tomkins & Schlangen 2007; Nriagu 2011; Singh et al. 2010). On a positive note, the inclusion of office elements, such as height-adjustable desks that permit workers to change postures throughout the day, is beneficial for users' health (Karakolis & Callaghan 2014; Robertson, Huang & Larson 2016). To understand these risks, benefits and their interactions, evidence based on a holistic, positive and proactive approach to health is required. This is in contrast to evidence based on the prevailing risk minimisation perspective (Bauer et al. 2019; Dilani 2009).

At the industry level, workers' health and well-being are being discussed, and some large corporations adopt interventions to promote workers' health and well-being. Supportive,

healthy environments are yet to become mainstream and available to all office workers (International WELL Building Institute 2017; Jones Lang LaSalle 2017). A gap exists between evidence of successful health-positive interventions and some current workplace environments (Bunn 2016; Hedge 2017). Exploring the reasons for this disconnection could provide valuable insight and provide a basis for improvements. As health and a salutogenic approach are pivotal to this study, they will now be defined and introduced. Other relevant definitions will be presented later in this chapter.

Health defined

The WHO defined health in 1948 as 'a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity' (Burton 2010, p. 15). By acknowledging that health goes beyond the absence of disease, this definition is consistent with salutogenic principles (Mittlemark 2017).

In the context of the work environment, the WHO's definition of a healthy workplace adopts a holistic perspective:

> *A healthy workplace is a place where everyone works together to achieve an agreed vision for the health and wellbeing of workers and the surrounding community. It provides all members of the workforce with physical, psychological, social and organizational conditions that protect and promote health and safety. It enables managers and workers to increase control over their own health and to improve it, and to become more energetic, positive and contented. (Burton 2010, p. 15).*

In this study, the 'physical' part of this health definition is the predominant focus. While mental and social well-being are recognised as integral to overall individual health, the impact of the workplace's physical environment is central to this thesis. While the physical workplace design can impact mental health outcomes, elements such as workplace culture are outside the scope of this study.

'Salutogenesis' defined

When exploring the development of approaches to health, the work of American medical sociologist, Anton Antonovsky, is foundational (Bauer et al. 2019). Antonovsky introduced the concept of focusing on people's capacity to create health rather than adopting the traditional approach of disease prevention (Bauer et al. 2019; Lindström & Eriksson 2005; Roskams & Haynes 2019).

Antonovsky (1996) observed that improving health status depends on a person's resources and capacity to maintain and improve those resources (Antonovsky 1996; Roskams & Haynes 2019). He proposed the Salutogenic Model of Health (SMH) based on five

assumptions: Firstly, health is on a continuum between total ill-health and total health, the ‘ease-disease continuum’ (Antonovsky 1996). Secondly, a person’s history needs to be understood as it impacts their response to an environment or situation. Thirdly, salutary factors that promote movement or physical activity are important as they improve health. Fourthly, stressors faced by individuals can be pathogenic, neutral or salutogenic and can be addressed with one’s resources for coping or responding to negative situations. Lastly, ‘active adaption’ enables a person to move to better health with the right therapy or right environment.

A key element in Antonovsky’s work is the concept of Sense of Coherence (SOC) which describes a person’s view of life and their ability to deal with changing or stressful situations (Antonovsky 1996; Roskams & Haynes 2019). A person with a high SOC will choose the most appropriate coping strategy when dealing with a stressor, such as moving to a new workplace. Research by Antonovsky (1996) and Mittlemark (2017) suggest that a strong SOC is a reliable indicator of good health, while a low SOC predicts poor health. SOC consists of three elements:

- Comprehensibility: how people perceive their environments and how they make cognitive sense of the matter or stimuli at hand. A person with a high SOC is more likely to understand why an adverse or unexpected event occurs.
- Manageability: the extent to which people believe they have the resources to adequately meet the demands of a situation and control or influence the resources or situation.
- Meaningfulness: the extent to which people perceive that life makes sense emotionally and that something is worth engaging or committing to. (Antonovsky 1996).

The SMH has been developed further in some public health and health promotion studies, including (Dilani 2009; Roskams & Haynes 2019; Stokols 1992).

Health promotion defined

Health promotion is framed by Shain & Kramer (2004b) as a concept or philosophy that recognises what health means to individuals and how it is influenced by factors such as the environment. Stokols (1992) and Trowbridge, Worden & Pyke (2016) suggest that health promotion is more positive and holistic than a mainstream disease prevention approach.

In addition, Shain & Kramer (2004a) concluded that health promotion programs are most effective in enhancing health when interventions focus on individual and environmental factors, integrated and implemented simultaneously.

A good example of the benefits of combining salutogenic concepts such as SOC and health promotion has been studied by Bonmatí-Tomas et al. (2019). A four session salutogenic health promotion program over six months resulted in reduced perceived stress and increased physical quality of life of participants illustrating the value of combining the SMH into public health promotion programs in practice.

Health Promoting Workplace (HPW) has been defined by the Ottawa Charter of 1986 as a workplace implementing key health promotion strategies. It is a supportive environment that enables occupants to control determinants of their health (Motalebi 2018).

Aim of this study

This study aims to use a salutogenic approach to investigate the relationship between elements and factors of the office workplace and their impact on office workers' perceived health status. This research aims to respond to the following three principle questions:

- Which environmental elements have the greatest effect on the perceived health status of office workers?
- What are the key factors to consider when creating healthy office workplaces?
- What are the key factors during the design process that limit the consideration of health-enhancing office environments?
    - The results may inform the design of health-positive workplaces by identifying features that industry professionals can use to improve office workers' health. The final outcome of this study is to present recommendations for future workplace design for occupant health. This study will review industry practice to understand current approaches to the design of the contemporary workplace and potential links to the health status of office workers.
    - Analyse current literature to identify factors in the office environment affecting an individual's health status.
    - Review existing tools for measuring office workers' health status and industry rating tools for workplace environments.
    - Investigate the impact of designed elements and workplace factors on office workers' perceived health status.

The term 'element' is defined as 'part of something'(Cambridge University Press 2021b) so is used in this context to refer to parts of the workplace ecosystem, organisation or environment. The term 'factor' 'influences the result of something' (Cambridge University Press 2021b) so is used in this context in a broader sense with the intention of discovering outcomes.

From a salutogenic perspective, this research will focus not only on the physical office environment but also on other workplace factors such as workplace flexibility (hours and location), office location (address) and health-related facilities, and their impact on health status. Oseland (2009) suggested that physical environmental conditions can be classified as: physical conditions (light, noise, air quality), space (layout and plan), ergonomics (workstation and controls) and aesthetics. Categorisations of these physical environmental conditions will form the focus of the research:

1. **Individual Ergonomics:** the individual work point consisting of the work desk or workstation and task chair.
2. **Office landscape**: design, variety, density and layout of settings, spaces and elements such as internal stairs.
3. Also included are workplace practices arising from management decision-making associated with features of the office landscape; such as unassigned desking or activity-based working (ABW).
4. **Indoor Environmental Quality (IEQ)** includes air quality, air temperature and access to sunlight, acoustics and lighting.
5. **Other workplace-related interventions** including flexible hours, flexible work location, access to gyms, health programs and health promotion.

Thesis structure

The thesis is structured as follows:

Chapter One introduces the health-related issues affecting office workers, a growing proportion of the workforce. Research aims are also presented, and the overall thesis structure outlined.

Chapter Two provides the necessary background to the research by detailing past and present approaches to workplace design and occupant health. The concept of salutogenesis is introduced and its application to workplace design considered.

Chapter Three reviews the academic and industry-based literature on health and well-being in the office workplace. The review aims to identify shortcomings in current research and determine the best theoretical framework to inform the case study methodology.

Chapter Four reviews and evaluates existing qualitative and quantitative tools for measuring office workers' health and the physical workplace environment. Identifying the environmental and health and elements these tools measure, their strengths and weaknesses will inform the tools chosen for this study.

Chapter Five presents the research's methodology by first describing the theoretical framework and research design: a mixed methods studying using a case study. The rationale for using qualitative and quantitative methods in the mixed-methods design is presented. After that, procedures for data collection, analysis and interpretation are laid out. Two data chapters follow.

Chapter Six provides the findings from the site analysis and interviews. Data from two stages (two before-move sites and one after-move) are analysed. The data analysed for each stage are the qualitative interviews with key informants (KI), site mapping and administrative data, including building reports and organisational data such as absenteeism figures.

Chapter Seven is the second part of the results focusing on the quantitative survey findings. The survey data are analysed in three parts: the first compares the two before-moves sites; the second compares responses from before and after the move for both sites; and the third part analyses the survey data for patterns in the relationship between workplace elements and perceived health status.

Chapter Eight synthesizes data from both phases of the case study resulting in emerging meta-inferences. Five themes offer insights and implications for future office workplaces. The impact of the Covid-19 pandemic on future workplace design and management is also discussed.

Chapter Nine concludes this thesis with recommendations for office workplaces design that enable positive health outcomes. Implications of the findings, viewed through a salutogenic lens, are considered to describe a suitable framework for design and practice encompassing workers' health outcomes, promotion, and measurement.

As the office-based workforce grows, the negative impacts of an indoor sedentary work-life have become a significant public health issue. Placing workers' health at the centre of indoor workplace design and associated workplace policies may reduce sedentarism's negative impact and improve individual health outcomes. A siloed and pathogenic approach to managing workplace health needs to be reoriented to a positive and holistic approach. This research investigates what matters when considering office workers' health to inform future workplace practice where health is pivotal to design decision-making.

Definitions

The definitions of health and salutogenesis central to this thesis are detailed earlier in this chapter. Definitions of additional key terms are provided below:

Activity-based working (ABW) has been described by Hedge (2017) as workplace design that offers many types of settings to support the activities that people conduct in the office workplace. It allows workers to move about and located themselves in the preferred environment to best support their work from concentrative to collaborative tasks.

Base building is sometimes known as ‘shell and core’ which refers to the primary structure or envelope and shared spaces of a building and its systems including hydraulic, electrical and mechanical. The office workplace or tenancy is located within the base building structure.

Ergonomics is defined by Kroemer (2017) as:

> *the application of scientific principles, methods, and data, drawn from a variety of disciplines, to the development of engineering systems in which people play a significant role. Among the basic disciplines are psychology, cognitive science, physiology, biomechanics, applied physical anthropometry and industrial systems engineering.*

Occupational ergonomics, as defined by Punnett et al. (2009), is a framework to address preconditions for musculoskeletal, cardiovascular and mental health. It aims to improve the fit between the worker and their environment by optimising the design of work processes and the physical environment.

The term **sedentary behaviour** is used somewhat differently in different studies, but it broadly refers to behaviour during waking hours characterised by sitting or reclining while expending little energy (Neuhaus, Eakin, et al. 2014). While the measurement of energy expenditure varies across studies, Neuhaus, Eakin, et al. define it as less than or equal to 1.5 metabolic equivalents. A related term, **overall sedentary time,** is measured across the entire day (not just during time in the workplace), and **workplace sedentary time** refers explicitly to sedentary time occurring in the workplace.

Wellness has been defined by the National Wellness Institute as ‘an active process through which people become aware of and make choices toward a more successful existence’ (National Wellness Institute 2020). Wellness encompasses interconnected dimensions of health: occupational, physical, social, intellectual, spiritual and emotional (Hedge 2017, p. 410).

Well-being has been defined by Anttonen & Rasanen (2008) for the Finnish Institute of Occupational Health as

> *fulfilment of the important needs of individuals and the realisation of goals and plans set for one's life. Goal-orientated activity and commitment to tasks creates well-being. The concept of quality and productivity of working life has only recently evolved, and includes, for example, learning and social activities. (Anttonen & Rasanen 2008, p. 16).*

Workplace or office fitout incorporates all built elements of an office workspace, including building systems such as air conditioning and lighting. Furniture, fittings and equipment are often selected or specified by an architect or interior designer during the development of the project design and construction.

Chapter 2 Background

Introduction

Before exploring the impact of the office workplace on occupant health, the history of the office workplace and approaches to designing these indoor environments are briefly considered. This background provides a basis for understanding current design thinking and the design processes that inform the creation of contemporary Australian offices. This background also provides a basis for understanding impacts on occupants' health and identifying shortcomings in current practice that need to be addressed. The consideration of workplace design and implementation in this chapter includes the influence of the base-building, organisational constraints and the paucity of available evidence for practising workplace consultants. This consideration highlights the need to design workplaces that focus on occupants' health. Finally, the innovative concept of salutogenic design is discussed as a viable extension or alternative framework for workplace design practice in the future.

A brief history of the office workplace

Understanding the history of office workplace design thinking and practice provides a context for understanding contemporary design and construction. When the Industrial Revolution of the mid-nineteenth century drew attention to workers' productivity (Kroemer (2017), the office work process too was scrutinised, with a view to improving efficiency. Like factory production, office work required the performance of set tasks in a controlled environment. These tasks were undertaken in a defined location, an office, where work could be supervised, and the necessary tools located (Kroemer 2017).

In the early 1900s, informed by Fredrick Taylor's time and motion studies (Channell 2019), the Ford Motor Company rationalised assembly line production. At the same time, office procedures were streamlined and efforts made to improve office workflow. Propst (1968) and Greenbaum (2004) describe how offices began to resemble factory production lines with rows of identical workstations. Some offices even had conveyor belts to carry papers between desks. Taylor's 'scientific management' can be seen in early New York offices with rows of desks as if on a production line, permitting little movement by staff around the office (Haynes 2007).

Taylor's methodology formed the basis for an efficient and productive working process which dominated the culture and design of offices into the twentieth century (Saval 2015). In 1915, the 'modern efficiency desk' was created for the Equitable Assurance Company. The desk in common use was adapted by removing the roll-top and cabinet, leaving a flat surface. (Saval 2015).

In 1939, Elton Mayo and F.J. Roethlisberger researched the Western Electric Company in Hawthorne, USA, to understand any link between employees' performance and their workplace (Landsberger 1958; Saval 2015). These studies, which came to be known as the 'Hawthorne' studies, were the first to examine workers in their office environment (Landsberger 1958). The two studies measured workers' output in varying lighting levels and piece-workers output when paid for completed work rather than by a set wage. Despite different lighting levels between the control and test groups, productivity increased for both groups during the study period. Workers appear to have been motivated by the researchers' attention, so it was concluded that the interpersonal relations afforded by the space were more important for productivity than levels of illumination (Landsberger 1958; Oseland 2009). This phenomenon is known as the 'Hawthorne Effect' (Landsberger 1958). The Hawthorne studies drove management thinking to focus on organisational and social arrangements in preference to the physical design of the workplace (Haynes 2007). Research has continued to understand how environmental and design attributes influence workers' performance (Vischer 2008).

With a growing emphasis on space efficiency in real estate (Duffy 1992; Vischer 2007), the next notable change in the office environment was the design of the well-known cubicle (Saval 2014). Today the cubicle is a desk or workstation with surrounding screens or partitions higher than 1800 mm. Skyscrapers with office space began filling with 'cubes', and the open-plan office was born. The first cubicle-style workspace, known as 'the Action Office system', was designed in 1968 by US-based furniture manufacturer Herman Miller (Kroemer 2017; Propst 1968). The World Design Congress in 1985 observed that this system was the world's most significant industrial design in the period from 1961 to 1985 (Saval 2014). Cubicle-style offices marked the beginning of a move away from traditional individual private offices. Today, this trend continues with a range of open-plan layouts being the norm in contemporary office spaces (Saval 2015). Layout, density and configuration can vary widely depending on an organisation's size, management direction and culture.

During the 1960s and 1970s, as work practices shifted towards collaboration over individual work, 'mobile and flexible working practices' emerged (van Meel (2011). The IBM case study completed by Allen & Gerstberger (1973) detailed an open-plan office space with unallocated desking designed to allow staff to alter their seated location based on their current task or team. The purpose of this setup was to increase collaboration within teams. Allen & Gerstberger (1973) evaluated the IBM office for over a year using weekly surveys to assess communication patterns amongst office workers which were compared to those of a control group. The research found that the arrangements improved internal communication, although workers were initially reluctant to embrace the new

arrangements. Nevertheless, in the longer term, workers came to accept the changed office environment. This pattern of initial reluctance and eventual acceptance is common in case studies of moves to open collaborative environments. For example, Kim et al. (2016) found that workers who moved to an unallocated environment (i.e.no fixed work point for each occupant) did not want to change back to allocated desks, particularly those required to spend time out of the office. Much office design during the 1960s and 1970s focused on productivity and improving communication (Meijer, Frings-Dresen & Sluiter 2009). Little attention was paid to health.

By the end of the 20th century and into the early 21st century, workplace design and interior fitout focused on environmental attributes (Leaman & Bordass 2007; Marans & Spreckelmeyer 1982; Vischer 2008). Office workers' individual needs and interests were, at last, being recognised, as was their health (Leaman & Bordass 2007; Vischer 1989). In 1995, the PROBE (Post occupancy Review of Building Engineering) project was the first research project of its kind to gather occupant feedback on elements such as design, construction and operation of a building (Cohen et al. 2001). This research marked the beginning of a formal process of post-occupancy feedback that extended beyond determining a building's technical and energy performance to consider occupants' needs (Cohen et al. 2001).

In 2014, the World Green Building Council (WGBC) published its report, *Health, Wellbeing and Productivity in Offices* which provides extensive research and global examples demonstrating that the design of green-rated buildings and office space impact occupants' health. Other research has also identified links between environmentally-sustainable or green-rated buildings and occupants' health and satisfaction (Singh et al. (2010); Xue et al. (2019); and Thomas (2010). Industry commentary and practice suggest that contemporary approaches to workplace design are slowly bringing occupants' health to the forefront, deviating from the last major trend in workplace design that focused on collaboration and productivity. Previous discussions of employee health centred on risk, safety and impediments to productivity (Hedge 2017) rather than on individuals' well-being (International WELL Building Institute). A report by Jones Lang LaSalle (2017) presented the views of industry leaders and professional bodies on the 'ideal' workplace of 2030. The report concluded that 'the wellness movement has become mainstream' and predicted that by 2030 a wellness approach would become firmly entrenched 'at the core of real estate solutions'. A wellness paradigm, the report claimed, would impact the way people work well before 2030 (Jones Lang LaSalle 2017, p. 9).

Office workplace design practice and health

Traditionally, the health and safety of employees have been the responsibility of a few professionals internal or external to an organisation; these professionals generally view

health through a risk mitigation lens (Dul & Neumann 2009; Hedge 2017). These professionals include human resources (HR) managers, workplace health and safety (WHS) officers and occupational health and safety (OHS) staff. Until recently, HR professionals and workplace consultants had little involvement in the workplace design process (Hedge 2017). Instead, real estate management and workplace teams were responsible for the physical space in which work was conducted. In contrast, the HR group has been responsible for managing employees' health, safety and well-being; but have had little involvement with the workplace design that impacts these. The process of delivering a new office can be relatively linear, with the effect that, at the design phase, knowledge of what is important to workers for their physical health may be limited (Colenberg, Jylhä & Arkesteijn 2020). HR professionals are often only involved in the early stages of brief preparation; workplace consultants translate these functional briefs for the designers. HR staff may not be given a further opportunity to provide input. Furthermore, a linear design process limits opportunities for input from experts at later stages by revisiting the resolved design solution to address any possible shortcomings before implementation.

Multi-professional research and evidence-based solutions are essential for creating healthy workplaces (Colenberg, Jylhä & Arkesteijn 2020; Ruohomäki, Lahtinen & Reijula 2015). As early as the 1950s, the UK's Chief Architect, Bill Allen, stated, 'building research should be no more than one step away from a design decision' (Leaman & Bordass 2001, p. 130). Without this inclusion of evidence or relevant expertise, good design intentions may not translate into best practice. For example, the inclusion of height-adjustable (HA) desks without promoting how and why to use them may prevent the full benefits of HA desking from being fully realised. Although many specialist consultants are involved in workplace design, few are trained in human health and have a sound understanding of the impact of design decisions (Trowbridge, Worden & Pyke 2016). WHS managers have traditionally focused on safety, harm minimisation and risk mitigation in industries with physical and manual work tasks. It has been less common for WHS managers to work proactively in an office desk-based environment to introduce health and well-being initiatives, such as reducing sedentary time (Hedge 2017). As larger corporations begin to see the productivity gains of a happy and healthy workforce, roles covering HR, OHS, and employees' general individual well-being are becoming more commonplace (Anttonen & Rasanen 2008). Organisations that recognise their workers' well-being are more likely to be successful than those that do not (Anttonen & Rasanen 2008). Health professionals, employment and workplace design experts are now collaborating, but for long-term improvements in worker's health, such collaboration needs to become standard practice.

Designers and specialist consultants and company, real estate, and facility managers each have a part to play in the briefing, development, execution, and delivery of workplaces.

Each consultant brings their practical knowledge and expertise to project solutions; however, little data has been collected to validate and measure project outcomes and health impacts providing benchmarks for future projects (Aristizabal et al. 2019; International WELL Building Institute 2017; Trowbridge, Worden & Pyke 2016). Some organisations invest financial resources in designed elements and settings within the office workplace without fully understanding the relationship between the effectiveness of these interventions and office workers' health (Colenberg, Jylhä & Arkesteijn 2020). In addition, a siloed approach that separates the responsibilities of those involved in workplace implementation could be a limiting factor in designing health positive office workplaces (Hedge 2017; International WELL Building Institute 2017). While several health-related measurement tools exist, not all studies use the same tools to measure particular health impacts such as musculoskeletal pain or ergonomic set-up, making benchmarking and comparison with other data difficult (Aristizabal et al. 2019; Hanc, McAndrew & Ucci 2019).

Ergonomists or health professionals who carry out workplace health-related assessments are often part of the evaluation process for larger projects. Evaluation criteria may be based on a relevant Australian standard or similar government guidelines. While this increases an evaluation's rigour, these criteria often fail to recognise the value of new products developed by product manufacturers' extensive research and development. Employers and companies selecting office furniture often need to balance their employees' support, comfort, and health with commercial imperatives such as finances and budgets. Yet, the selection of ergonomic task seating may be made by decision-makers who lack the necessary ergonomic knowledge and who are motivated primarily by cost minimisation. For example, a lower quality task chair is unlikely to be sufficiently adjustable for the range of required tasks or accommodate a broad range of body sizes. Nor may they provide adequate postural support for people who sit for long periods during their working day (Groenesteijn et al. 2012).

While staff engagement in design decisions can be empowering, most users cannot easily see the supportive ergonomic features of a chair and are more likely to nominate a chair based on their aesthetic preferences (Helander (2003). Furthermore, aesthetics can sometimes override functional requirements and end-user needs, potentially compromising health outcomes. Designed spaces that are 'cool' or follow a popular trend may ignore the health implications of their users. For example, designers may specify task seating that allows them to select a matching textile rather than on the chair's ergonomic benefits. Many office workers sit for 70% of their working day, and the selection of inappropriate task seating can significantly impact their comfort and musculoskeletal support (Hadgraft 2016).

In addition to the office chair, the desk or workstation can also impact workers' health and is often the topic of much discussion in workplace projects. Interior designers may

nominate a specific workstation based on their interpretation of the clients' needs and their preference for design aesthetics and layouts. A functional brief of a workstation may include adjustability, size, cable management, technology integration, privacy and storage requirements, all of which impact the final user (Vink & Kompier 1997). Desk or workstation designs vary considerably in size, configuration and functionality depending on location, budget, functional requirements and interior design trends. In general, desks can vary from 900 mm to 2100 mm in length and 700 mm to 900 mm in depth. Functional requirements for office desks or workstations are set out in the Australian Standard AS/NZS 4442:2018 (Standards Australia 2018). The standards include guidelines for evaluating, designing, and implementing safe and comfortable work environments for people performing screen-based tasks; this would include almost all office workers. The Australia Standard does not provide any specific guidelines for health; however, ergonomic principles and correct ergonomic setup are detailed. Adopting these ergonomic principles can ultimately impact occupants' health and safety by reducing the risk of musculoskeletal complaints or injuries. Despite good intentions, budget is often the main determinant of whether a workstation is fixed height or height-adjustable, impacting the extent to which the user can stand throughout the day. HA workstations are becoming more common in Australian workplaces, as manufacturing costs have been reducing. However, no sales data is publicly available on the volume of HA desks and fixed-height desks in the Australian market.

Beyond the desk and chair, workplace design and overall layout can positively and negatively affect employees' health (Hedge 2017; Heerwagen et al. 1995; Roskams & Haynes 2019). The design of a workplace can affect how people feel and their loyalty to the organisation, their work performance, and the generation of new ideas (Vischer 2008). Vischer (2008) posits three domains of the workers' experience of the workplace: user satisfaction and functional comfort, territoriality or sense of belonging and productivity. WGBC (2014) calls upon real estate and development professionals to consider the impacts of office workplaces on workers' health, well-being and productivity. The WGBC's report, indicative of growing industry momentum to address these issues, examines the relationship between office building design and its impact on occupants. The report includes practical suggestions for measuring impact to support ongoing improvements.

Many organisations acknowledge the importance of evidence in understanding the health impacts of office environments (Jones Lang LaSalle 2015; Trowbridge, Worden & Pyke 2016). In a collaboration between the Mayo Clinic, Delos and a number of universities, a test site, *Well Living Lab,* has been established in New York. Researchers have used this space to measure employees' responses to nine different types of office environment (Aristizabal et al. 2019). The study aimed to understand how particular environmental variables interacted and how each impacted individual and group performance and health.

The authors saw the need for such research because, despite widespread recognition of the importance of employees' health, few high-quality studies in this area had been conducted. They observed that what is needed are studies with adequate participant numbers, control groups and which are conducted over suitable time frames (Aristizabal et al. 2019). Furthermore, as these studies used standardised measurement, their results can be compared against benchmarked data (Aristizabal et al. 2019).

Factors impacting health-focused workplaces

The design and layout of interior and exterior environments can influence the daily experience and health outcomes of the people who use and inhabit them (Fisk 2000; Rasheed, Khoshbakht & Baird 2021; Seppänen & Fisk 2006). A building's design influences the final indoor workplace environment, as does its location and the organisational priorities of its owners or lessees. These factors affect the users' experience of these interior spaces and have implications for their health (Zimring et al. 2005). The following discussion aims to highlight the factors that most significantly influence office workspace project outcomes. World Green Building Council (2014) reports that occupants of green-rated buildings are healthier and happier; which the report attributes to higher Indoor Environmental Quality (IEQ), access to views and sunlight and overall high quality of amenities. The report also highlights that despite good evidence demonstrating that office design impacts health, well-being and productivity, the property industry is yet to translate this to mainstream decision making (World Green Building Council 2014). For example, if an interior workplace is housed in a poorly-designed building, individual health can be compromised by elements such as lack of access to daylight, lower air quality or reduced thermal comfort (Duffy 1992; Saari et al. 2006; Thomas 2010; van den Berg et al. 2008).

Other building constraints that are beyond the control of the tenant or designers include ageing environmental control systems, large deep floorplates and inadequate façade glazing (Aristizabal et al. 2019; Saari et al. 2006). While the impact of IEQ on occupant health is well documented (Bluyssen et al. 2011; Mujan et al. 2019; Wolkoff 2013), it is often difficult to isolate the impact of specific IEQ elements. IEQ results from a combination of factors, including building envelope design, façade design, building policies, systems and human activities (Aristizabal et al. 2019). Likewise, the placement and organisation of structural and circulation systems can also influence health. For example, a fire stair located near lifts that can be easily accessed can enable office workers to use stairs throughout their day (Centre for Active Design 2010b).

A workplace's physical location affects access to local amenities, spaces for physical activity, options for active commuting and commuting times. These factors, in turn, impact workers' health. These factors are recognised in the health-focused WELL Building Standard (Morton 2015), discussed in Chapter 4.

The location, type, size, and density of the built workplace is determined by an organisation's priorities and will ultimately impact the workers' experience and health. Costs of the various components of an interior fitout are allocated according to the organisation's priorities (Zimring et al. 2005). For example, some organisations may allocate budget to areas that customers visit, while other companies may include extensive employee facilities such as on-site gyms and dining spaces. In a case study of the St George Bank workplace at Kogarah, NSW (Hassell 2019), extensive employee facilities such as social and health spaces were provided to attract and retain employees to the Bank's suburban location.

The inclusion of health-related facilities in building design is partly attributable to building ratings that focus on health and well-being, such as WELL Building Standard and Fitwel Standard (Candido et al. 2020). While these standards advance the awareness and implementation of health-positive elements, early adopters may seek the rating itself rather than long-term health benefits for their employees. In response to space pressures and high rents, some organisations have sought to improve efficiency by increasing space utilisation, often increasing occupant density. This can be seen from a comparison of occupant densities in Sydney and Canberra. In 2015, Sydney occupant density averaged 14 m^2 with average rent costs of \$612.50/m^2 pa. In Canberra, density was lower, at 16 m^2 per desk, with much lower rent costs of \$244.10/m^2 pa (Cushman & Wakefield 2015). High occupant density impacts the final built workplace experience and the perceived health of the occupants. Herbig, Schneider & Nowak (2016) found an unfavourable impact of high-density open-plan spaces on occupant health, especially for roles with little need for communication and interaction. Furthermore, Saari et al. (2006) suggested that if space utilisation is increased to save costs, the costs of increased ventilation must be included to maintain occupants' health and productivity.

The workplace strategy, ABW, which is increasingly being adopted in Australia, can also result in organisations saving space and rental costs. ABW workplaces have fewer desks than occupants requiring workers to move about and choose settings for their varied daily tasks (Candido et al. 2018; Hedge 2017). Evidence is mixed on the health impacts of ABW workplaces (see Chapter 3). Current industry data suggests that a comfortable and efficient workspace ratio is eight desks to every 10 workers, or one occupant per 14 m^2 (Caloutti 2019). Industry rarely publishes after-move assessments with before-move comparison data. While some case studies exist, designers may be unaware of them. Further, designers may focus on creating innovative spaces rather than using concepts that are 'tried and tested'.

Competing financial constraints during the design phase of a workplace project can impede adequate consideration of employee health. In addition, reducing delivery time frames may generate savings in rent and consultants' fees. Compressed schedules may limit research

opportunities and opportunities to include health expertise in tailoring design solutions to the organisation and workplace. Some office workplaces are designed and constructed on a speculative basis for commercial leasing purposes so that the design cannot take account of the particular needs of future occupants. Anttonen & Rasanen (2008) summarised the need to balance organisational and individual needs by

> *creating an environment that promotes a state of contentment, allowing an employee to flourish and achieve their full potential for both their own benefit and that of their organization. (Anttonen & Rasanen 2008, p. 19)*

The cost implications and potential health and productivity gains of improved IEQ are clearly described by Wargocki (2011) and illustrate the need to look beyond simplistic real estate figures of densities and rates per m^2. Nriagu (2011) pointed out that potential health and productivity benefits are generally not included in standard real estate and operations calculations. A 1% increase in office workers' productivity can offset the annual costs of effectively ventilating a building, and the cost of installing and operating building ventilation systems can be offset by productivity gains of approximately 10% (Nriagu 2011). These figures show that improving IEQ can have significant economic benefits. This is supported by the review completed by Singh et al. (2010), which showed that employees with adverse health conditions had higher sick leave rates, worked fewer hours and were often less productive.

Few peer-reviewed case studies of spaces that make a difference to employee health and well-being have been conducted. Hedge (2017) examined the Medibank workplace at 720 Bourke Street, Melbourne, which comprised 46,500 m^2 over seven floors. This workplace was designed to promote the health and well-being of the workforce. Incorporating a dominant staircase increased the average step counts of occupants by 1400 compared with other Medibank offices. This healthy and positive work environment also included 3,500 indoor plants and circadian lighting, both of which have been shown to have a positive impact on occupant health (Figueiro et al. 2017; Mills, Tomkins & Schlangen 2007; Nieuwenhuis et al. 2014).

Designing for health

Some researchers have advanced reasons for the lack of attention to evidence-based, health-focused solutions in the design of office environments (Bunn 2016). Cross (2001) distinguishes between a design-based and a science-based approach:

> *Method and repeatable process is critical in the practice of science where it validates results while in design it is almost more important for the results not to be reproduced or copied and not be repeated.*

The importance of generating original workplace designs may partially explain why some designed environments are not health-positive spaces for occupants. Further, clients' expectations that spaces be tailored to perceived unique organisational processes, culture and outcomes may influence designers to focus on factors other than workers' health and well-being. Additionally, this approach is widely promoted in corporate settings as organisations seek unique workplaces customised to their needs that may not ultimately focus on the health of their employees.

Health and design professions have contrasting cultures and motivations and diverse disciplinary practices (Chamberlain 2018). These differences present a significant challenge in practice as decision-making may be misaligned. For example, a creative designer may develop ideas and concepts with a strong focus on aesthetics. At the same time, a health professional may only adopt a proven method that can be objectively measured. In this situation, for the professions to work together in the design of HPWs, the diversity of knowledge, skill, and practice needs to be recognised and further understood so that traditional professional boundaries can be transcended (Chamberlain 2018). This need is not new. In 1964, Alexander wrote:

> *Scientists try to identify components of existing structures, designers try to shape the components of new structures. (Alexander 1964, p. 130)*

Around the same time, another influential author, Simon (1969), stated:

> *The natural sciences are concerned with how things are; … design, on the other hand is concerned with how things ought to be. (Simon 1969, p. 58)*

Interior designers, architects, scientists, and health professionals each have a role in developing workplaces that address workers' health and well-being (Kroemer 2017). Barriers to effective collaboration need to be identified if they are to be overcome, including problems with processes, possible tensions, possible shortcomings and other barriers presenting in workplace implementation practice today. Standardised solutions to the challenge of designing workplaces for health are difficult to achieve because workplace determinants of health are interrelated, varied and complex (Roskams & Haynes 2019). A salutogenic approach to workplace health is proactive and positive in fostering the strategies that improve workers' health, rather than merely addressing safety, risk or ill-health (Pazell (2018). The current practice in workplace design lacks a positive and proactive approach to health; this fact motivates the use of a possible alternative framework.

Using a salutogenic approach for workplace health

A well-designed office workplace can support the health and productivity of its occupants (Candido et al. 2020; Trowbridge, Worden & Pyke 2016; World Green Building Council 2014). Despite this, much research has focused on risks, problems, symptoms, illnesses and other negative impacts. A systematic review by Bluyssen et al. (2011) aimed to understand the complex relationship between building conditions and human well-being in office spaces. The review identified the importance of incorporating knowledge from experts from both health and building science. Linking evidence from the health sciences to safety and risk programs is necessary to improve workers' well-being (Hedge (2017).

A framework for workplace design that supports all levels of human health and well-being is required to harness opportunities for enhancing employees' health (Ruohomäki, Lahtinen & Reijula 2015). Similarly, Roskams & Haynes (2019) propose that a salutogenesis-informed framework is best suited to supporting and promoting workers' health.

Being universal and easily adaptable, salutogenesis is the ideal framework for workplace design and implementation (Roskams & Haynes 2019). Antonovsky (1996) stated that a salutogenic orientation provided direction and focus for health promotion and could be modified or tailored to a specific workforce or organisation. Bringing together evidence-based design with health-promoting principles creates the foundation of a salutogenic model for workplace design. According to Ruohomäki, Lahtinen & Reijula (2015), when considering how to design workplaces using a salutogenic approach, designers need to ask themselves:

- What are features, elements or settings that could support or even promote the well-being of users?
- What kind of workplaces could enable and support working?
- What kind of workplaces could maintain and enhance the health of workers?
- What are the characteristics of healthy spaces other than the lack of negative elements?

This principle of promoting health and well-being as a central element of design is a departure from current thinking in which the approach to workplace health is one of risk mitigation and injury prevention using various ergonomic interventions (Abdelaal & Soebarto 2019; Buckley et al. 2015)). Ruohomäki, Lahtinen & Reijula (2015) and Roskams & Haynes (2019) identify elements or dimensions of the workplace that can support human health and well-being and provide insight into the potential benefits of a salutogenic, user-centred and participatory approach to workplace implementation.

Antonovsky (1996) encouraged a multi-disciplinary approach to developing health-positive work environments, often lacking in current workplace design and implementation. For example, a multi-disciplinary team is required when a zoo is designed and built. Biologists, designers, animal specialists, landscape architects and building experts work together to provide the optimal environment for animals to live, eat, rest, sleep and socialise (Heerwagen et al. 1995). Due to fragmented organisational structures, collaboration between specialists such as ergonomists, project managers, human resource managers and designers is difficult (Mittlemark (2017). Stokols (1992) proposed that design solutions for HPWs focus on physical, mental and social health:

- Physical health is promoted by holistic ergonomic design as part of a healthy, clean, non-toxic and non-pathogenic environment.
- Mental health is promoted by having some personal control over spaces and having low distractions within a reasonably predictable structure.
- Social health is promoted by fostering social connections, participation in the design process and organisational flexibility and responsiveness.

Heerwagen et al. (1995) have developed Stokol's (1992) work further by identifying physical spaces and settings in the workplace based on salutogenic design principles. These are described as:

- Formal and informal meeting and collaborative settings and spaces encourage social cohesion. Depending on the work of the organisation, these spaces will vary in quantity, settings and size.
- Quiet spaces that allow for contemplation or relaxation provide specific areas for individuals to restore throughout their working day.
- Environments in which the individual can have some control over their space, such as regulating lighting, daylight access and temperature.

Salutogenic design and current practice

In the context of Heerwagen et al. (1995) salutogenic guidelines, ABW environments – which allow occupants to move around the workplace, choose spaces and settings and provide an opportunity to control their environment – seem well-suited to affording health benefits to their users. Hedge (2017) enumerates the ergonomic benefits of ABW. ABW workplaces help organisations meet the individual needs of their workers; employees can 'craft' their environment depending on work conducted or individual preferences (Roskams & Haynes (2019). Physical activity and enabling moving about throughout the working day are key factors in improving the health impacts of the office workplace (Hua & Yang 2013; Meyer et al. 2010; Rassia 2014; Zimring et al. 2005).

A salutogenic, holistic approach that focuses on both individuals and organisations can inform the policies and practices that optimise health and well-being. For example, workplace design with unassigned desking is part of an ABW workplace policy that enhances activity throughout the working day (Candido et al. 2018; Kim et al. 2016). Stokols (1992) further observed that 'health promotive' policies can be applied at multiple levels within a site – from the micro-level through to the larger environment context – and are most effective when aligned with management policies. While health promotion should be informed by evidence and a suitable theoretical framework, programs need to be flexible and tailored for each organisation depending on their requirements and the objectives of such a program (Khanal et al. 2016).

Any approach to health promotion needs to be integrative, bringing together ergonomics, company wellness or health programs, and associated health policies (Punnett et al. 2009). Organisations frequently design wellness programs and workplaces but consider ergonomics independently (Hedge 2017). Ergonomics is viewed as a health and safety function, while wellness programs focus on nutrition and exercise (Hedge 2017). Dul & Neumann (2009) recommend that the design of workplaces to promote health is on a continuum with the design of workplaces to promote safety. Given the inter-connectedness of health and safety, Hedge (2017) suggests that the ideal approach to workplace design includes attention to health promotion and encouragement of healthy behaviours, as well as assuring safe work performance.

The COVID-19 pandemic has many implications for office workers' health and safety and for office design. Mitigation of disease transmission risk has been a critical health and safety issue in the office context. Another implication arises from office closures and working from home, which has health implications, particularly through the ergonomics of home set-ups (Arlington 2020; Geisler 2020). While the former is outside the scope of this research, the latter emphasises the need to better understand how health practices within the workplace might influence worker well-being. Establishing and promoting sound health practices within the workplace becomes of greater importance when managing remote or home workers (Arlington 2020; Geisler 2020; KPMG 2020)

Summary

Design and function of the contemporary office has developed over the decades due to technology advancement, changing demands and expectations of owners and building occupants. The need to positively support workers' health and well-being is a significant global issue, as sedentary-related diseases have increased as office-based work has increased (Australian Institute of Health and Welfare 2016; Ding et al. 2016). As a result, a conversation is occurring between the property industry, design professionals and within organisations about the need to effectively address employee health and well-being

(Trowbridge, Worden & Pyke 2016). While the impacts of some indoor elements such as air quality are well known, the adoption of best practice in design for health is limited. We need to examine which elements or workplace factors impact health and if they are effectively utilised and measured (Colenberg, Jylhä & Arkesteijn 2020). Although studies have been conducted on the health effects of IEQ and other individual workplace design elements, a more holistic, salutogenic perspective is required (Dilani 2009; Heerwagen 1998). A step towards integrating health and risk in the workplace is to activate the current literature on salutogenesis and develop a salutogenic framework for everyday practice.

To effectively improve health in the workplace, interventions should be evidence-based. The following chapter reviews relevant research on workplace design and elements, strategies, and factors that impact workers' health.

Chapter 3 Literature Review

Introduction

As the number of office workers increases, so does the importance of understanding the effect of their working environment on their health. A salutogenic approach to exploring the physical office environment and organisational workplace policies helps identify factors affecting workers' health and design solutions. Consistent with a salutogenic approach, an 'integrative' literature review was chosen as the best means of examining the literature on health in the workplace as it synthesises research from diverse sources (Cooper 1988). The first part of this literature review focuses on the indoor built environment and physical elements such as spatial layout and IEQ. The second part reviews associated organisational policy and practice, including health promotion, training and workplace flexibility. This integrative review of the literature on workplace design for health sheds light on the current state of knowledge in this field, identifies gaps in the literature and determines the need for future research (Toronto 2020; Wee & Banister 2016).

Cooper's Taxonomy of Literature Reviews (Cooper 1988) was used to inform the literature review process used in this thesis. Below is a summary of how this review addresses each component of the taxonomy:

Focus: This review focuses on practices and applications, for example, how a specific element has been designed and the associated outcomes. This is necessary to establish whether an element or intervention in practice is impacting health.

Goal: Identification of central issues. Identify any weaknesses or shortfalls in the methodology of past studies; determine the need for the research reported here and the best methodological approach for that research.

Coverage: Exhaustive with selected citations relevant to the specific topics. A defined set of parameters determines the inclusion and exclusion of research. The research included was limited to physical health only and office workers in office buildings.

Organisation: Conceptual. This review is structured by relevant aspects or theories, such as the effect of IEQ or the layout of the office workplace.

Audience: Specialised scholars. The intended audience is academic reviewers.

Purpose of this literature review

The purpose of this integrative review is to:

- Evaluate the literature associated with the various elements, factors and organisational strategies in the contemporary office workplace that impact the health of office workers.
- Identify central themes with a focus on practices and applications to understand what elements make a difference to workers' physical health in the workplace.

Using an integrative approach (Denney & Tewksbury (2013), key impacts on the health status of office workers will be realised. Understanding these health impacts may inform those designing and developing workplaces to better prioritise occupants' health and well-being in the future.

Search strategy

Keyword searches of the academic literature on health and built environment in electronic databases were undertaken. Searches of industry publications relating to the built environment and workplace practice were also carried out.

Searching took place between February 2016 and February 2018, with updates in December 2019 and December 2020. Literature from any year was eligible for inclusion to capture seminal works and to identify historical trends. The literature included skews towards the last decade or so, reflecting the greater volume of relevant research in that time period. The increased volume is consistent with the increased interest in office workers' health as the number of office workers in the global labour force grows.

In addition, a review of industry grey literature and conference proceedings was conducted, and relevant peer-reviewed literature referred to in that literature identified.

Keyword searching

The keywords included, but were not limited to, the following: *Workplace health, open-plan offices, sick building syndrome, health, well-being, height adjustable desking, indoor environmental quality, thermal comfort, task seating, office chairs, ergonomics, office acoustics, health programs, activity-based working, health status, office workers health, indoor air quality, salutogenesis, SF-12, salutogenic design, office ergonomics, lighting, daylight, access to daylight, active offices, flexible working, commuting, well-being measurement tools, office workers health status, professionals, biophilia, plants in offices, FITWEL, WELL, NABERS, Green Star ratings, Anton Antonovsky, wellness, wellness strategies, participatory ergonomics, history of the office, active design, post-COVID workplaces, post-pandemic offices, workplace design, health promotion, health education, sustainable buildings, muscoskeletal conditions, office density, office noise and office stairs.*

Databases and Sources

Several databases were searched to cover both health and built environmental aspects of this study. Databases included Avery Index of Architectural Periodicals, EBSCO (Health), EBSCO (Architecture), ProQuest Health, BioMed Central, EBSCO (Art and Architecture), Science Direct, Sage Journals, Australian Standards database, Taylor and Francis, SpringerLink and ProQuest Health & Medicine and SCOPUS.

Non-peer-reviewed but reputable industry publications, such as commercial interior and architectural magazines and journals, were also included; as were reports and other documents produced by architects, industry professionals and suppliers. These sources were considered valuable as design and practice sometimes precede peer-reviewed publications. For example, global architecture practices publish their research in books and articles. Leading manufacturers that conduct research and development for office furniture, such as Herman Miller, publish their findings as industry white papers and short essays.

Quality appraisal of the literature

Analysis was carried out in two stages using the Matrix Method suggested by Garrard (2017) for health sciences literature reviews. A structured approach allows each reference to be individually reviewed, then grouped, integrated and reorganised until the goal of generating a comprehensive understanding of the topic is achieved (Toronto 2020). Firstly, a data matrix (Garrard 2017) was created in Excel that listed each reference, publication date, element of study, methodology, sample size and the key findings. This Excel table continually evolved throughout the literature review process, allowing patterns and themes to surface and gaps to be identified.

These diverse sources, including peer-reviewed articles, journals, books and industry grey literature, were appraised for quality and inclusion using guidelines set out in the Mixed Methods Appraisal Tool (MMAT) User Guide (Hong et al. 2018). Although the ‘grey literature’ can be challenging to evaluate because quality ranges from biased, commercially motivated material to high-quality academic research (Agha-Hossein et al. 2013; Toronto 2020), some grey literature was nonetheless used in this review. To evaluate the quality of potentially relevant grey literature, the AACODS (Authority, Accuracy, Coverage, Objectivity, Date and Significance) checklist was used (Tyndall 2010).

Inclusion criteria

The opportunity for benchmarking or comparisons between studies is limited by the design of some studies due to small numbers of participants, short study duration, lack of a control group, or limited use of standardised measurement tools. However, no limit was set on sample size, as some studies provided valuable information even though their sample sizes were small. Eligible studies focused on physical health while those focused on mental

health, productivity or building performance were less relevant. Some non-health outcomes were also included. For example, while comfort is not generally included in definitions of 'health' (Burton 2010), studies addressing this were eligible for inclusion since people who are supported and comfortable report feeling healthier (Leaman & Bordass 2001).

Literature screening process

Figure 3.1 below shows the PRISMA diagram (Moher 2009) that summarises the literature screening process and provides the number of works in each category.

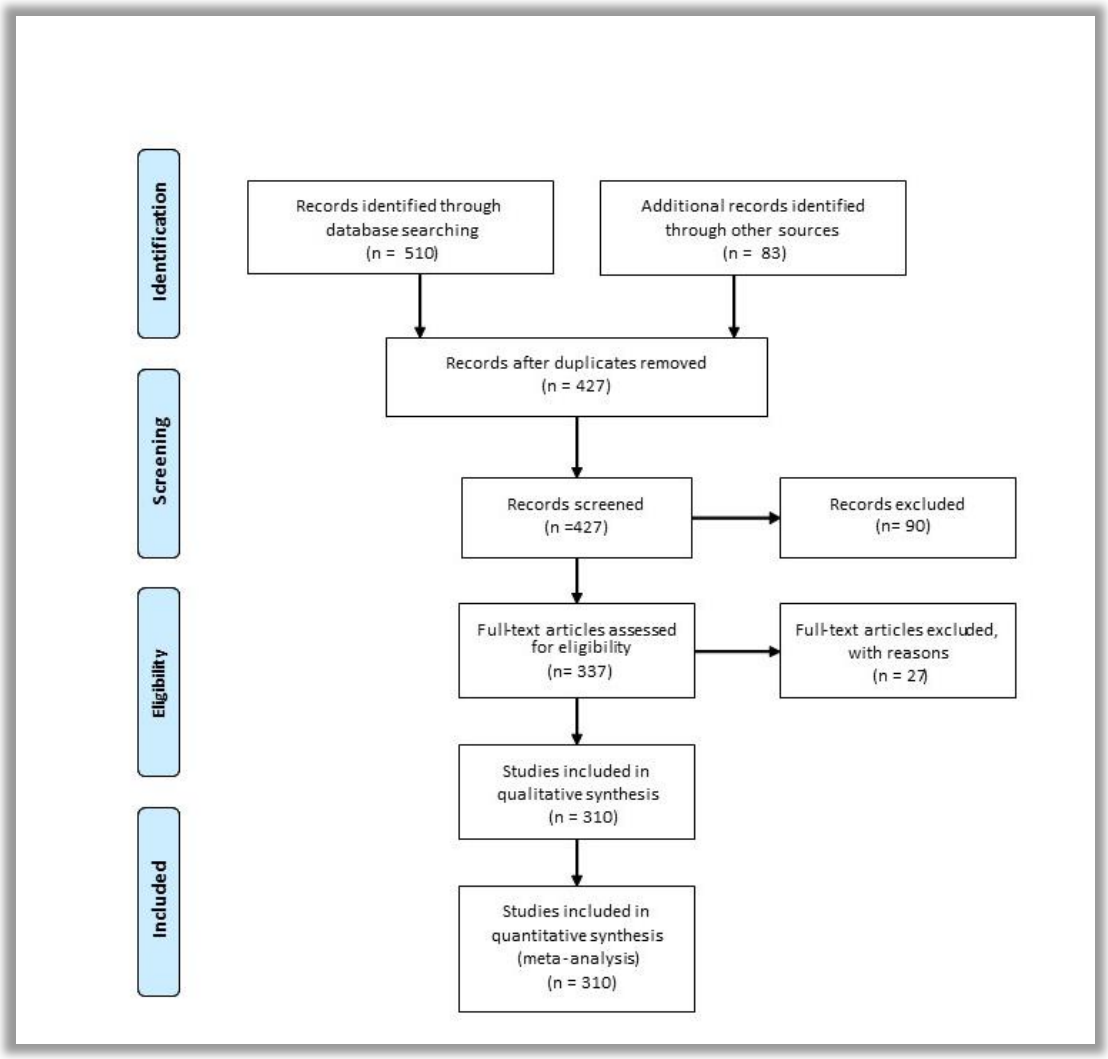

Figure 3.1 Literature review process using the PRISMA diagram (Moher et al. 2009)

Findings of the literature review

As a result of the integrative review process, the following broad themes were identified:

1. Sedentarism: the sedentary nature of office- or desk-based work and the health implications.
2. Individual Ergonomics: the individual workpoint, consisting of the work desk or workstation and task chair.
3. Office landscape: design, variety, density and layout of various settings, spaces and elements such as internal stairs and management practices such as unassigned desking or ABW.
4. IEQ: including air quality, air temperature and access to sunlight, acoustics, lighting and biophilia.
5. Factors beyond the physical workplace: including health promotion, ergonomic training, management practices and workplace flexibility policies.

This structure follows a similar format to that of Clements-Croome (2006), suggesting that the physical environmental conditions can be separated into physical conditions (light, noise, air quality), space (layout and plan), ergonomics (workstation and controls) and aesthetics. The following section discusses the peer-reviewed research on the individual elements that impact the health status of office workers.

The sedentary office and health implications

Research in industrial ergonomics and industrial health and safety shows that researching office ergonomics can be difficult as health conditions are subtle and often difficult to isolate (Grant 2000; Hedge 2017). Office workers' tools include computers, tablets, communication devices, keyboards, lighting, desking and seating. The WHO Global Strategy for Occupational Health (McArthur & Powell 2020) strongly recommends the adoption of sound ergonomic practice within any organisation. Punnett et al. (2009) defines occupational ergonomics as optimising job design and work systems by improving the fit between the workforce and the environment. Ergonomists are trained to support office workers by designing or arranging office spaces that streamline work processes, enabling them to work efficiently and safely, enhancing their physical and cognitive capacity (Hedge 2017).

The employee's role in the office environment will dictate how much of the day is spent at their workpoint or desk (Chau et al. 2019). Computer-based employees sit for extended periods, adding to the growing problem of increasing sedentary time and inactivity (Chau et al. 2010; Parry & Straker 2013; Sugiyama et al. 2020; Thorp et al. 2014). Preventable diseases that reduce life expectancy, such as Type 2 diabetes and heart disease, are linked to excessive sitting time and limited physical activity (Owen et al. (2010). A study of 231 office workers over 14 sites (Hadgraft et al. (2016) that examined the association between sitting duration, overall sitting time and factors such as workers' tenure time, body mass index (BMI), age, gender, skill level found that shorter tenure and lower BMI were associated with higher levels of prolonged workplace sitting time. The authors explained

these findings: senior staff are more likely to be meeting and moving around the office as they are required for decision-making, and heavier people find sitting for long periods uncomfortable, so they get up to break up sitting time.

The impact of sedentary time on health was addressed in a case study by Boyce et al. (2008). Almost 400 people with a mean age of 34 were studied over eight months after commencing work in a UK-based call centre. 68% of participants gained an average of 0.9 kg per month, and only those who conducted vigorous exercise outside work avoided weight gain. This study is notable as it is one of the few studies that included objective biometric data. Another study that has quantified the impact of sitting time was completed by Sugiyama et al. (2020). Cross-sectional associations of waist circumference and sitting time of 5,878 participants (3,006 desk-based and 2,872 non-desk based) confirmed that longer sitting time at work was associated with greater waist circumference, especially in male workers.

Owen (2010) used data from the Australian Diabetes, Obesity and Lifestyle Study of 11,000 people to look at the frequency of breaks from sitting. Comparing people with the same overall amount of sedentary time, those with more breaks had a 6 cm smaller waist on average than those with fewer breaks, regardless of other moderate- or vigorous-intensity activity time. This study suggests that interruptions in sitting time may be enough to counter some effects of sitting in the office and that height-adjustable (HA) desks may support this behaviour. Thorp et al. (2014) also tested this type of intervention to understand if intermittent standing periods during the workday could improve subjective levels of musculoskeletal discomfort, fatigue, and productivity. Twenty-three overweight or obese people were tested over five days in a laboratory setting. Although a small study, the assessment methods were valid and sufficiently detailed to conclude that transitioning from seated to standing (or another posture) every 30 minutes reduced fatigue and discomfort with no loss of productivity.

Individual ergonomics: the office desk and chair

Height-adjustable (HA) desks or workstations

As more designers specify – and more organisations procure – HA workstations, the research on their effects is increasingly relevant to workplace health. Features of HA workstations addressed in the literature include the impacts of the desk type on energy expenditure (Tudor-Locke et al. 2014), musculoskeletal discomfort (Robertson, Ciriello & Garabet 2013) and associated activities such as training (Robertson, Ciriello & Garabet 2013). Barriers identified in systematic reviews of research on HA desking (Chau et al. 2010; Torbeyns et al. 2014) identify several methodological weaknesses applicable to some studies: short duration, lack of control groups, and small sample sizes. These methodological shortcomings impact the robustness of findings and prevent comparisons

between studies (Chau et al. 2014; MacEwen, MacDonald & Burr 2015; Neuhaus, Eakin, et al. 2014; Thorp et al. 2014). Desks that are height adjustable, enabling workers to stand during the working day, have become part of the contemporary workplace. Also known as ‘Sit-Stand’ (SS) or ‘Sit-to-St’, HA workstations allow users to either sit on a standard task chair, stand, or use a stool (Thorp et al. 2014). The height range in the current Australian Standard (AS466:2018) is approximately 620 mm to 1,300 mm from floor level. The percentage of fixed desks to HA desking varies depending on the organisation's size, work conducted, risk assessment and management decisions. The market adoption of HA desking is unknown, as suppliers generally do not make their sales data publicly available. An indication may be, however, that most Australian Federal government departments are 100% HA or SS desking (Australian Government Department of Finance and Deregulation 2013).

Research on HA desking in the office environment indicates that HA desking affects many health-related factors, including sedentary time, comfort levels, musculoskeletal conditions, cognitive function and physiological outcomes. A 2013 systematic review of 38 peer-reviewed articles summarised many recent studies of ‘activity permissive’ or HA workstations (Neuhaus, Eakin, et al. 2014), of which 19 were field studies (within an actual office workplace) and 19 were laboratory investigations. Eight of these studies were conducted in Australia. Sample sizes consisted of two 2 to 66 people. In the meta-analysis, data from 984 people who conducted computer-based activities while at their desk were collected before and after the installation of a SS or HA desk. HA workstations were found to reduce sedentary time, with a pooled effect size of -77 mins of sedentary time over an eight-hour workday. Neuhaus, Eakin, et al. (2014) advised that the results be viewed with caution due to the methodological quality and small sample sizes in many of the reviewed studies. Few detrimental effects on health-related outcomes were reported across all studies reviewed by Neuhaus (2014).

A study undertaken in Brisbane, Australia (Alkhajah et al. (2012) took place over a relatively long time frame (three months). Thirty-two office workers (18 in the intervention group and 12 in the control group) were allocated either to a HA desk or a standard fixed desk. Data were collected before desk allocation (baseline), one week, then three months after baseline. Data, measured by an activity monitoring device during waking hours, were time spent sitting, standing and stepping. At one week, sitting time at work was an average of 142 minutes lower in the intervention group than in the control group. At the three-month mark, the difference was similar, with the intervention group sitting for 137 minutes per day less than the control group. Despite the small sample size, Alkhajah et al. (2012) used objective measurement and demonstrated that incorporating HA workstations reduced office sitting time.

Subsequent studies have explored the inclusion of HA desking integrated with either ergonomic education, desk-use training or communication of health benefits and have obtained similar results (Healy et al. (2013); Robertson, Ciriello & Garabet (2013). The combination of HA desk and education resulted in the greatest changes in sitting time. A small non-randomised control trial was completed in Melbourne in 2013 (Healy et al. 2013). Data were collected from 18 participants in the intervention group and 18 in the control group over four weeks. Participants were given three key messages ‘‘Stand Up, Sit Less, Move More’’. Workplace sitting time was reduced in the intervention group by a mean of 125 mins over the eight-hour day. Prolonged sitting time (sitting longer than 30 minutes) was also reduced.

Energy expended at work is a marker for workplace physical activity. Tudor-Locke et al. (2014) reviewed 32 studies examining energy expended in people using different workstation types. Energy expenditure changed little between sitting and standing at a workstation. Walking was found to use more energy than sitting in an experiment where treadmill walking desks and seated pedalling desks were compared for total calorie burn. HA desks did not increase energy expenditure over fixed desks (Tudor-Locke et al. 2014). As well as examining sedentary time as described above, Alkhajah et al. (2012) study looked at the effect of HA desks on weight and body composition. The intervention group showed a weight reduction over the three months but no changes in body composition relative to the control group. Overall, the benefits of standing desks were greatest for people with obesity.

Adoption of HA workstations may also reduce discomfort without impacting the productivity of the user. Karakolis & Callaghan (2014) reviewed 14 studies to understand the effectiveness of HA workstations on user discomfort. HA workstations were found to reduce whole body and lower back discomfort, and some studies indicated that standing for long periods can cause hand and wrist discomfort. Musculoskeletal and visual discomfort in the office environment was the focus of Robertson, Huang & Larson (2016) large scale cross-sectional survey of more than 1,200 people within a large organisation. Fifty-seven percent of respondents had experienced discomfort such as musculoskeletal complaints while performing their desk-based tasks. The survey also found that those more satisfied with their workspace generally reported less discomfort and health concerns.

As discussed above, many of the systematic reviews of HA workstations noted some limitations of the methodologies used in the reviewed studies (Chau et al. 2014; Torbeyns et al. 2014). For example, Chau et al. (2010) reviewed six studies and trials of HA workstations that aimed to increase energy expenditure. Five studies were randomised controlled trials, and one pre-post study. One study used a pre- and post-test design.

Sample sizes of the reviewed studies ranged from 66 to 2,121 participants (Chau et al. 2010).

The authors warned that due to varied methodological approaches, time frames and delivery methods, it was difficult to draw specific conclusions on the most appropriate intervention to increase physical activity. Another contributor to the authors concerns about evidence quality was the use of self-report data in many of the studies included in the review (Chau et al. (2010). With the advent of wearable devices able to measure a range of health markers, the use of objective data is likely to increase (Engelen, Chau, et al. 2016). Torbeyns et al. (2014) completed a systematic review of the effect of HA or active workstations on health, cognition, energy expenditure and work performance. The authors noted that many of the 32 studies were moderate to good quality and concluded that, overall, HA workstations that enabled activity contributed to improved activity levels. However, the authors noted the difficulty in comparing the 32 studies because of differences in definitions, study parameters (such as varied testing of cognition), cohort sizes and study time frame.

In conclusion, the incorporation of HA desking in office workplaces reduces sitting time and provides opportunities for standing while completing individual tasks (Chau et al. 2014; Healy et al. 2013; Neuhaus, Healy, et al. 2014). However, the magnitude of benefits, such as increased energy expenditure (Alkhajah et al. 2012; Tudor-Locke et al. 2014), and reduced discomfort (Karakolis & Callaghan 2014; Robertson, Huang & Larson 2016) need further investigation. For improving health outcomes, the optimal time spent sitting, standing, stepping and on breaks is yet to be determined. While HA seating shows promise as an intervention for workers' health outcomes, its specific health benefits are not fully understood. Therefore, longer-term and robust studies are required to further understand this area of workplace design (Chambers, Robertson & Baker (2019); MacEwen, MacDonald & Burr (2015).

Task seating

As more of the world's workforce is sitting for increasingly prolonged periods, the need for a high-performance task chair that offers support and comfort is becoming increasingly important (Buckley et al. 2015; Hedge 2017). The chair provided with an individual desk is an 'office chair, 'task chair' or 'task seating'. The Australian Standard AS/NZS 4438:1997 HA swivel chairs (2016) sets out the functional requirements of an office chair, including durability, stability and strength and provides a set of selection or evaluation criteria. Having been developed in 1997, the Standard does not consider subsequent developments in office seating that have improved materials and technologies. This creates problems for workplace ergonomists and health consultants when trying to comply with the Standard. The choice of workplace task seating depends not only on ergonomics but the priorities of

decision-makers who consider other factors such as cost and aesthetics. The health implications of task seating are important, given the length of time spent by office workers in a seated posture (Hedge 2017) – up to 82% of their office time (Parry and Straker (2013). However, the academic peer-reviewed literature on the health impact of the office task chair is sparse.

In a study of user requirements for task seating for specific office work tasks, Groenesteijn et al. (2012) obtained the responses of 12 people to five different chair types. Observations by the researchers identified four office tasks: computer work, telephoning, desk work and conversations. The chairs were assessed on features such as materials, adjustability, size of users and comfort. Seated users moved the most when engaged in conversation and the least when working on a computer. The researchers also identified that seating needed to permit various movements during various work tasks, support the spine, and adapt to different body sizes.

Office work, particularly computer work, can cause eyestrain. Amick et al. (2012) assessed different types of ergonomic chair to determine whether they impacted the visual symptoms of eyestrain. One hundred and sixty people were divided into three groups: those who received a new highly adjustable chair, those who received ergonomic training only and no new chair (the control group) and those who received both. Data were collected over 12 months and showed that the group receiving both the chair and training had less eyestrain than those receiving either the chair or training alone. The effect was maintained more than twelve months after the intervention. The findings were robust due to the large sample size and long timeframe.

A systematic review by van Niekerk, Louw & Hiller (2012) evaluated five studies of office chairs, three of which were randomised control trials. Participants numbered between four and 293. The review showed that an adequate task chair and training in its use reduced workers' musculoskeletal symptoms. As was the case for HA desking (Healy et al. (2013) Alkhajah et al. (2012), training in the correct use of a task chair resulted in improved health outcomes (Amick et al. 2012; van Niekerk, Louw & Hiller 2012).

A salutogenic and holistic approach encourages a combination of interventions to improve health outcomes, such as integrated health promotion and training, and attention to the physical elements of the office workplace.

Office landscape: design and layout

The layout of an office affects employees in multiple ways, from overall comfort and satisfaction to the opportunity for incidental physical activity (Candido et al. 2018; Colenberg, Jylhä & Arkesteijn 2020). De Croon (2005) conducted a systematic review of the effect of office layout on workers' health and performance. Almost 50 studies were

identified dating from 1972 to 2004. Results indicated that open workplaces reduced job satisfaction and privacy. In addition, higher density and open environments reduced interpersonal relations and affected cognitive workload, while desk sharing improved communication. De Croon et al. (2005) concluded that organisations and ergonomists of innovative workplaces should consider the office workers' individual needs and well-being. Many studies undertaken since the 1970s have sought to understand the implications of design elements such as open-plan layout, setting configuration and occupant density (Bergström, Miller & Horneij 2015; Danielsson & Bodin 2008; Hongisto et al. 2016; Pejtersen et al. 2011).

Various configurations of contemporary office models or designs, are reviewed in this thesis for their physical health implications. Some models of workplace layouts, such as those incorporating ABW, are relatively new, so peer-reviewed research on their impacts on occupants' health is limited (Candido et al. 2018; Mackey, Engelen & Foley 2015). The office layouts relevant to this research include:

- open offices and open layouts
- ABW environments and unassigned workplaces
- active workplace environments

Open offices and open layouts

Reviewing the effects of open-plan offices offers many examples of occupants' negative outcomes, experiences, and perceptions (Richardson et al. 2017). Bergström, Miller & Horneij (2015) conducted a rigorous 12-month longitudinal study of 82 participants, which investigated perceived health and self-estimated productivity one month before, then three, six and 12 months after relocation from individual offices to an open-plan office environment. Information was collected by questionnaire that included items from the Salutogenic Health Indicator Scale (SHIS), the Work Experience Measurement Scale (WEMS) and one question from the Work Ability Index (WAI). These will be reviewed in the next chapter. Respondents' self-reported health, perceptions of the physical work environment and performance decreased during the twelve months after the move. Participants also reported increased noise levels, increased tiredness after work and increased sedentary time (Bergström, Miller & Horneij 2015). Scores on the health-related SHIS items were significantly lower three and twelve months after the move than at baseline. These results show that the open-plan office had a deleterious effect on perceived health. Self-rated productivity also decreased. In support, analysis by Khoshbakht, Baird & Rasheed (2021) of 5000 surveys from 67 commercial and academic buildings found office spaces with fewer workers generally attained better health scores. Occupants in single offices reported the highest health score followed by the working group of six to nine workers (Khoshbakht, Baird & Rasheed 2021).

The health impacts of environmental changes can also be gauged by changes in absenteeism or sick days (Richardson et al. 2017). A survey of more than 2,000 office workers by Pejtersen et al. (2011) found that people working in open-plan offices took more sick leave than people working in private offices. Workers in four different workplace layouts – single-person offices, two-person offices, offices shared by three to six people, and open-plan areas accommodating six people or more – provided self-reported health and sociodemographic data. Health data collected included self-reported BMI, number of sick days, smoking habits, and physical activity. While self-reports of factors such as the number of sick days may be subject to recall bias, research with British civil servants found that self-reports of sick days were accurate when cross-checked against administrative records (Pejtersen et al. 2011). Compared to occupants of single-person offices, the average number of sick days increased in all other office types:

- two-person offices had 50% more sick days.
- three- to six-person offices had 36% more sick days.
- open-plan occupants with more than six people had 62% more sick days.

Pejtersen et al. (2011) provided possible explanations for higher sick leave in shared or open-plan offices:

- Higher exposure to noise, causing stress.
- Differences in types of ventilation used in closed and open spaces.
- More exposure to viruses because of more shared surfaces and changes in airflow.

The amount of sick leave was also found to vary by office type in a study of 469 office workers by Danielsson & Bodin (2008). This study, which took place in Sweden, sought to understand the influence of seven different types of office space on workers' health status and satisfaction. In three of the open-plan office types, short-term sick leave was significantly increased, and gender differences were identified between types of office space. For example, for large open-plan offices, women were more likely to take sick leave than men. For men, increased sick leave was associated with flexible offices.

On the other hand, a study by Meijer, Frings-Dresen & Sluiter (2009) involving 140 workers that focused on health outcomes related to an open-plan office environment found that at 15 months post-move, workers' perceived the change to have improved not only their productivity but also their general health, as measured by the SF-36 (p = .011). Sugiyama et al. (2020) also present positive findings from a review of 20 articles relating to office spatial layout and sitting time. Sugiyama et al. (2020) concluded that open-plan offices with visibility of co-workers resulted in less overall sitting time and shorter duration of sitting time than those in closed offices.

In addition to open layouts, occupant density is another element requiring consideration. Oldham (1988) conducted an investigation in which 65 administrative workers moved from an open-plan office to either an office with partitions surrounding individual employees or a low-density office with greater usable space per employee. The groups were measured three months before and three months after the changes. Overall, self-rated performance was unchanged in the new office environment; however, work satisfaction was higher when spatial density was low, with or without partitions.

Past studies on the relationship between spatial layouts and health outcomes have produced mixed results, depending on which factors were measured and how they were measured. Open offices were found to have negative health outcomes by Bergström, Miller & Horneij (2015), Danielsson & Bodin (2008) and Pejtersen et al. (2011). On the other hand, Meijer, Frings-Dresen & Sluiter (2009) reported improvements in health status in more open layouts. As each workplace environment and organisation is unique, it is difficult to generate a standardised approach or model for understanding the effect of office layout on occupant health.

ABW Environments

In recent decades, office layouts have been changing to offer functional spaces in which people can conduct various tasks throughout their working day. To address some of the shortcomings of open-plan office environments, ABW workplaces have been designed and implemented in a growing number of Australian organisations (Candido et al. 2018). ABW is defined by Mackey, Engelen & Foley (2015) as an office design in which workers share a common workspace consisting of diverse environments to accommodate a variety of office tasks. Hedge (2017) explains that an ABW enables a choice of setting based on the type of work required. Potential barriers to working effectively, such as noise and distraction, may be overcome by an ABW design layout.

Providing various settings and spaces allows people to move about and change postures, thereby reducing sedentary time (Foley et al. 2016; Kim et al. 2016). A noteworthy example of an Australian ABW case study was conducted by Foley et al. (2016) of Sydney's Telstra workplace pilot space. This study aimed to evaluate the effects of ABW on activity time, sedentary time, musculoskeletal discomfort, and work ability. Eighty-eight workers completed three types of self-reporting questionnaire one month before moving to the trial space, during their temporary occupation of the trial ABW space and one month later on return to their former non-ABW office space. The questionnaires collected data on sitting during the workday and leisure-time physical activity, work ability and musculoskeletal discomfort. For the collection of objective data, participants wore accelerometers (GT3X+) at each measurement time point. For the ABW pilot environment, self-reported seated time was 14% less than in their former non-ABW office environment and standing time

increased by 11% (Foley et al. 2016). However, data measured by accelerometer did not reflect these self-reported changes; instead, it showed no significant changes in sedentary behaviour, although an increase in steps taken was found.

Unassigned environments

Unassigned desking, 'free address' or 'hot desking', is a feature of workplaces where workers share desks and move to other desks in the office environment depending on the people with whom they are working or tasks to be completed. Unassigned desking often occurs in ABW environments discussed above. Unassigned desking is generally implemented to increase space efficiency (Kim et al. 2016), although unassigned desking may also be implemented to encourage greater collaboration, as workers will sit with team members to work on shared tasks.

Many larger corporations have implemented unassigned work environments (Candido et al. 2018; Engelen et al. 2018; Kim et al. 2016). The health implications of this office environment type are yet to be fully understood. This concept considers that individual desk usage or utilisation is often below 50%, so desks can be shared, and utilisation can be significantly improved. A certain percentage of a workforce will not be at their workplace due to sick leave, annual leave, external meetings or training, so their desks can be utilised when they are absent. The ratio of desks to people can be adjusted depending on the organisation's requirements. Kim et al. (2016) have analysed space allocation in 20 organisations, finding an average of 12.8m^2 per desk. These authors noted that increased density did not necessarily result in lower occupant satisfaction, perceived productivity and health (Kim et al. (2016). To gain a complete picture of occupants' experience, factors in addition to density need to be considered, including the occupants' perceptions of privacy and crowding (Keeling, Clements-Croome & Roesch (2015).

Despite the growing popularity of the unassigned office layout model, limited empirical peer-reviewed research has examined its impact on health (Candido et al. 2020; Engelen et al. 2018). From a satisfaction viewpoint, Kim et al. (2016) statistically analysed data from the Building Occupants Survey System Australia (BOSSA) survey to see if unassigned desking affected occupants' self-reported satisfaction and productivity. BOSSA is an officially accredited rating tool that assesses IEQ within the National Australian Built Environment Rating System (NABERS) and the Green Star Performance system. BOSSA uses an online survey to assess the satisfaction of building occupants (see Chapter Four). Interestingly, environments with predominately non-fixed or non-assigned desk arrangements offered more meeting areas and break-out spaces per desk, which could account for the higher satisfaction for this group (Candido et al. 2020; Candido et al. 2018; Kim et al. 2016). When workers choose their desk location, they have the opportunity to adapt to ambient conditions or 'personalise' their working space, albeit temporarily. For

example, a worker may choose a location based on their air quality and thermal conditions preferences. Kim et al. (2016) found that ‘space for breaks’ and ‘comfort of furnishings’ were the two strongest predictors of negative self-assessed health for fixed and non-fixed work points. The comfort of furnishings was the main predictor of positive self-assessed health. For unassigned or ‘non-territorial’ workplaces, Kim et al. found that occupant-perceived health was adversely affected as satisfaction with furniture comfort or break-out space decreased. These findings align with the Roulet et al. (2006) analysis of over 2,000 surveys in 64 office buildings which found a strong correlation between perceived comfort and reported building-related health symptoms.

In summary, definitive conclusions on the long-term health impacts of ABW and unassigned workplaces are not yet possible. However, it is clear that such workplaces encourage moving about to complete daily work tasks and hence are more ‘active’ (Candido et al. 2020; Foley et al. 2016; Kim et al. 2016).

Active workplace environments

As the evidence base for the negative consequences of sedentarism grows (Parry & Straker 2013; Sugiyama et al. 2020; Thorp et al. 2012), interior designers and workplace strategists respond by designing ‘active workplaces’ (Alfonsin et al. 2018; Probst et al. 2012). These workplaces are specifically designed to encourage movement and increase the number of steps taken by office workers (Engelen et al. 2017; Jancey et al. 2016). Pronk (2015) defines an active workplace as a company or place designed to encourage movement and reduce the sedentary time of workers by deploying a range of organisational strategies and physical layout modifications. An active workplace may include internal staircases to encourage walking between floors rather than taking the lift and will consider the location of amenities, such as kitchens and bathrooms, to encourage people to walk further (Pronk 2015). Active workplaces need to be designed and implemented at all levels, from the individual, team, and the organisational and physical environment.

Strategies to encourage workers to be less sedentary and more active need to be easy to adopt and to be supported by all (Pronk 2015). The Medibank Headquarters in Melbourne is an excellent example of an active workplace supported by organisational culture and policies. Offices have a prominent staircase at the core of the design (Hedge 2017). Medibank, Australia’s largest private health insurer, took a strong interest in promoting the health of its employees by providing an active workplace environment emphasising the movement and health of its employees. Pronk’s (2015) case study showed that, on average, employees in the headquarters site took 1,400 more steps per day than other Medibank staff located in other offices (Hedge 2017).

Another case study from Australia further supports the view that the physical design of the workplace can be altered to affect office workers' physical health (Jancey et al. 2016). Forty-two participants were studied before and after moving from an older-style, 1970s building in Perth to a new purpose-built space. The new space included an internal staircase, shared facilities and an open layout. Using accelerometers, Jancey et al. measured any change in physical activity between occupants of the two office types. Demographic and anthropometric data were also collected. A decrease in daily sitting time of 5.2% was found for occupants of the new space, reflecting a mean decrease in sitting time of 20.62 minutes and a mean increase in standing time of 22 minutes. Similar results were obtained by Engelen, Dhillon, et al. (2016), who conducted a study of 34 participants who moved into a new active design building on a university campus. The self-report survey showed that workers at the active workplace experienced reduced back pain, reduced sitting time and more time standing than in their old workplace; walking time remained unchanged. The new environment provided many opportunities for walking, suggesting that the finding that walking time did not change may be a measurement effect. Objective data collection measures, such as accelerometer readings, as used in the Jancey et al. (2016), would provide more definitive results on the impact of this active environment.

A study of the health impacts of stair usage involving 77 participants was conducted over 12 weeks by Meyer et al. (2010). Several health indicators such as fat mass, waist circumference and cardiovascular capacity all improved over the study period. Meyer et al. concluded that encouraging stair use at work was a simple but effective way to improve cardiovascular health outcomes. However, Engelen et al. (2017) conducted a study in three university buildings to identify if motivational signage to use the stairs instead of the elevators would increase stair use and passive exercise. Observations were made six times at baseline and during the intervention. A minimal effect of the signage on stair use was found.

Layout and the configurations of elements within the floorplate impact the amount of walking completed throughout the office day. In studying the impact of office layout and setting configurations on occupants' behaviour, Hua & Yang (2013) proposed three hypotheses to be tested. The first hypothesis (H1) was that 'office workers are less sedentary when their workstations are a further distance from shared amenities than those closer to shared spaces' (Hua & Yang 2013, p. 374). Using surveys, pedometers and analysis of floorplans, the study found that spatial layout and adjacencies increase the movement and activity of workers. Workers who had further to walk to share spaces were more active and more satisfied with the workplace and organisation. Rassia's (2014) research that sought to understand the relationship between layout, office features, and physical activity supports these findings. Six UK office floorplans were examined using

direct observation, self-report questionnaires and accelerometers. The most frequent trips were to colleagues' desks, the kitchen and the bathrooms. The researchers also found that occupants were attracted to windows and other architectural features, which increased their movement. The authors concluded that building circulation systems, including staircases with large windows or a view, motivated workers to increase daily steps taken (Rassia 2014).

Layouts and accessible stairs allowing for incidental physical activity throughout the working day as part of an active workplace positively impact health outcomes. Studies by Jancey et al. (2016), Meyer et al. (2010), Hua & Yang (2013) and Rassia (2014) showed that layout changes and improved access to stairs increased occupants' walking time and reduced sitting times. However, Mackey's (2015) study observed a self-reported increase in movement but no increase in movement as measured by the accelerometer, a reminder of the potential limitations of self-reported data.

Indoor Environmental Quality (IEQ)

IEQ includes elements such as noise, natural light, air quality and temperature (Nriagu 2011). Factors contributing to IEQ are complex, dynamic and interdependent, making them difficult to isolate and measure (Mujan et al. 2019). The built form that houses a workplace has many elements that affect occupants' health and well-being. Growing evidence suggests that poor IEQ can lead to adverse health and productivity outcomes (Colenberg, Jylhä & Arkesteijn ; Mujan et al. 2019; Seppänen & Fisk 2006; Vimalanathan & Babu 2014). Fisk & Rosenfeld (2000) have estimated that improving IEQ may improve productivity by between 0.5% and 5%. For example, in one study, doubling the outdoor air supply rate reduced illness and absenteeism by approximately 10% (Nriagu (2011). Studies of IEQ's effects do not provide consistent results because different methods and metrics have been used in different studies (Mujan et al. (2019).

IEQ has financial implications. Employees' salaries are approximately 100 times building costs or 92% of annual investment (Nriagu 2011). Improvements in IEQ that increase employees' productivity will significantly improve the business's bottom line (Fisk 2000). As millions of people live, work, and study indoors, understanding optimal indoor conditions and the impact of IEQ is of significant value (Vimalanathan & Babu 2014).

In a review of 120 studies on health, comfort and productivity in the office workplace, Mujan et al. (2019) identified four key factors as the main contributors: thermal comfort, indoor air quality, acoustics and visual comfort. Their study found that air quality and thermal comfort had the greatest interdependency hence were difficult to measure independently. This suggests that a more holistic approach to the indoor environment is required. In contrast to Mujan et al. (2019), Lamb & Kwok (2016) found that noise and lighting annoyance caused

the most significant environmental stress (ES), while thermal comfort did not significantly affect work performance. Lamb & Kwok (2016) conducted a longitudinal study of possible effects of wind-induced building motion of 114 office workers in 66 different New Zealand buildings over eight months. The purpose of this study was to investigate the effects of IEQ on work performance and well-being by collecting data from 2,261 online surveys measuring perceived thermal comfort, noise annoyance, lighting comfort, work performance and individual state variables such as distractibility, tiredness and motivation. The study found that symptoms such as headaches, lower mood, and feeling unwell were associated with increased ES.

Improving overall IEQ has resulted in small yet significant improvements in workplace performance and workers' well-being (Candido et al. 2020; Colenberg, Jylhä & Arkesteijn ; Leder et al. 2016; Vimalanathan & Babu 2014). The effects of IEQ on health are difficult to measure, as IEQ's components form a dynamic ecosystem (Bunn 2016; Clements-Croome 2006; Lamb & Kwok 2016; Mujan et al. 2019; Wolkoff 2013). Another point to consider regarding IEQ is that the occupant response to environmental conditions may be more holistic than compartmentalised (Jamrozik et al. 2018). The IEQ research mentioned above is part of a large body of post-occupancy evaluation (POE) studies that assess and report occupants' satisfaction, comfort and productivity, although less attention is paid to health in POE studies.

Indoor Air Quality (IAQ)

Occupants of office buildings may be exposed to a range of airborne pollutants, including microorganisms and chemicals coming from within and outside the building. Indoor Air Quality (IAQ) is challenging to measure. It incorporates many physical and chemical parameters, including chemicals, odours, particles and other airborne concentrations, which are highly interdependent and fluctuate considerably over time (Wolkoff (2013). IAQ may be affected by outdoor conditions, building systems, spatial layouts and occupant density (Clements-Croome 2006), all of which vary dynamically, making it difficult to isolate specific elements to occupant health. Another variable in reporting is the amount of time spent in the office environment (Rasheed, Khoshbakht & Baird 2021). Occupants that spent less time in the office reported less influence of IEQ factors on the health, productivity and comfort.

The WGBC's 2014 report (World Green Building Council 2014) described a 2006 meta-analysis of 24 studies that included six offices. The study found that poor air quality (and elevated temperatures) consistently lowered the performance of occupants by up to 10%. Singh (2010) analysed before- and after-move office sites in Michigan, USA. When the 207 occupants moved from a conventional office to a LEED (Leadership in Energy and Environmental Design)-rated building with improved IAQ, a reduction was found in

perceived absenteeism, and self-reported improvements were found for asthma and respiratory allergies. Wolkoff (2013) recommended measuring selected compounds on an ongoing basis to avoid the harmful effects of reduced IAQ on occupants' health. Poor IAQ has cost implications for organisations and individuals (Nriagu (2011). Direct health consequences included an increase of two days in sick leave annually and increased break-taking at work (Nriagu 2011). These direct effects resulted in a 1% reduction in the effectiveness of work. This cost-benefit analysis of IAQ in this study suggested the need for these health and productivity benefits to be included in economic calculations associated with building design and operations (Nriagu 2011).

Poor IAQ directly impacts occupants' health resulting in increased absenteeism and reported respiratory conditions (World Green Building Council (2014); Singh et al. (2010); Nriagu (2011). Reported health impacts attributed to air quality should be viewed cautiously, as they may be related to thermal comfort.

Thermal comfort

Thermal comfort is a subjective condition and is described as a 'state of mind which expresses satisfaction with the thermal environment' (American Society of Heating & Air Conditioning Engineers 2004). The office thermal environment is complex and consists of interdependent variables such as air temperature, air speed, humidity and surrounding surface temperatures such as the temperature at a window (Jamrozik et al. 2018; Mujan et al. 2019). As most Australian offices are air-conditioned, the temperature is moderated within a narrow range, which largely prevents significant temperature fluctuations. However, maintaining the temperature within a narrow range may not be necessary for workers' to experience thermal comfort (Arens et al. (2010). A study of occupant comfort and acceptance of the thermal environment used three databases of hundreds of office building field studies concluded that a tightly controlled air temperature environment did not improve overall satisfaction (Arens et al. (2010). The authors attributed this to the diverse range of individual requirements and responses. Furthermore, actual temperature may differ from individuals' perceptions which are affected by metabolic rate, clothing and personal preferences (American Society of Heating & Air Conditioning Engineers 2004). Outdoor seasonal conditions also affect thermal comfort, as indicated by Baird & Field (2013) review of 36 commercial office buildings. Occupants perceived indoor conditions as too cold in winter and too warm in summer. Although thermal comfort does not appear to be an immediate risk to physical health, it may be a significant factor in productivity (Lan, Wargocki & Lian 2011; Vimalanathan & Babu 2014). In the PROBE study, workers who felt comfortable also reported being more healthy and productive (Leaman & Bordass 2001). Hence, thermal comfort is a crucial element of the indoor environment (Herbig, Schneider & Nowak 2016; Kim & de Dear 2012; Leaman & Bordass 2001; Roulet et al. 2006).

Access to daylight

Lighting quality and access to daylight can significantly impact office workers' health and well-being (Boubekri et al. 2014; Fostervold & Nersveen 2008; Mills, Tomkins & Schlangen 2007). The brightness and wavelength of ambient light affect the human circadian system, mood and alertness (Mills, Tomkins & Schlangen (2007); Figueiro et al. (2017). Figueiro et al. (2017) assessed the impact of daytime light exposure on sleep and mood in 109 office workers in five buildings. The use of light that is effective for the human circadian system in the morning improved sleep quality and reduced sleep onset latency. This study also found that daylight access was positively associated with mood, measured using the SF-36. Mills et al. (2007) concluded that further research is required to fully quantify the impacts of office lighting on workers' health and wellbeing.

Exposure to daylight is essential for maintaining human circadian rhythms and good general health (Bjørnstad, Patil & Raanaas 2015). Boubekri (2014) conducted a small study of 49 participants; 27 in windowless environments and 22 in areas with significant daylight. Workers in offices with windows slept an additional average of 46 minutes per night and had better overall sleep quality. Using the SF-36 health status survey, respondents from windowless environments recorded lower vitality, social functioning and mental health scores (Boubekri et al. 2014). The effects of access to daylight were also examined in case studies of Lockheed Martin and Verifone workplaces (Romm & Browning 1994). Exposure to maximum daylight resulted in a 15% decrease in absenteeism. Similarly, Mills et al. (2007) conducted a study of 69 call centre workers in the UK to determine the effect on health of exposure to daytime light of different colours and brightness (high correlated colour temperature). Data, including responses to the SF-36, were obtained at baseline from two groups and again three months later. Substantial improvements were found in the intervention group in fatigue (26.9%), alertness (28.2%) and work performance (19.4%). These findings suggest that high correlated colour temperature lighting may be a practical intervention to improve productivity and overall well-being.

The evidence from these studies suggests that access to daylight and exposure to circadian-effective lighting impacts sleep quality and duration – key elements of health and well-being (Boubekri et al. (2014); Figueiro et al. (2017); Mills, Tomkins & Schlangen (2007). With this in mind, workplace design should prioritise daylight access.

Acoustics and noise

A building's design impacts how noise and acoustics are controlled and experienced by occupants (Seddigh et al. 2015). The WHO describes noise as 'any unwanted sound' (World Health Organization 2002). Acoustics is complex and involves many disciplines from physics, engineering and psychology (Hedge 2017). A recent review by Colenberg, Jylhä & Arkesteijn (2020) of four studies examining noise-related effects in the office environment

found that high levels of background noise impacted speech intelligibility caused fatigue, annoyance and disruption.

The acoustics literature addresses the impact of acoustics on productivity (Nriagu 2011; Rasheed, Khoshbakht & Baird 2021), performance (Seddigh et al. 2015; Vimalanathan & Babu 2014) and satisfaction (Heerwagen et al. 1995). Little research in the acoustics field has considered links between office acoustics and physical health. An office's acoustics can negatively affect occupants' comfort, well-being and productivity. Perrin Jegen & Chevret (2016) identified noise as the main source of discomfort in the office workplace. Al Horr et al. (2016) observed that noise affected occupants equivalent to that of thermal comfort: a temperate change of 1^{o} Celsius has the same effect on productivity as a noise change of 2.6 dB. Mujan et al. (2019) found that ongoing exposure to increased levels of internally- or externally-generated noise could increase blood pressure and levels of stress hormones. Lamb & Kwok (2016) found that increased environmental stressors such as noise led to reduced productivity. (Rasheed, Khoshbakht & Baird 2021) also concluded that noise levels impacted workers' productivity with less reported impact on comfort and health.

Open-plan offices can increase noise and distraction levels compared to private offices, which can provide some acoustic privacy (Bergström, Miller & Horneij (2015) Heerwagen et al. (1995). A solution is implementing designs, such as ABW, that enable occupants to move to a location within the office that best meets their personal acoustic needs or preferences (Hedge (2017). For example, a quiet space offering total acoustic privacy can be used for highly concentrative work, while open meeting spaces can be used for collaborative or team activities. Some acoustic product manufacturers offer tools for designers to determine the right level of acoustics in office spaces for optimal comfort and productivity (Craven 2018; Seddigh et al. 2015).

There is good evidence that workplace performance and productivity are impacted by noise (Bergström, Miller & Horneij 2015; Rasheed, Khoshbakht & Baird 2021; Seddigh et al. 2015; Vimalanathan & Babu 2014). However, the effects of noise on office workers' health are less well established and require further research (Rasheed, Khoshbakht & Baird 2021).

Biophilia

Biophilia is the 'innate human affinity for nature' (Kellert & Wilson 1995; Sanchez, Ikaga & Sanchez 2018). Incorporating natural elements in the design of indoor spaces may benefit workers' health and well-being (Sanchez, Ikaga & Sanchez 2018). Biophilic design is defined by Kellert (1995) as the design of environments that incorporate features such as indoor-outdoor landscapes, natural ventilation and materials, natural lighting, views of the outdoor landscapes, water features and natural landscaping. In the modern built

environment, biophilic design has been found to enhance occupants' well-being by fostering connections between people and nature (Kellert & Wilson 1995). These findings are supported by those of Heerwagen (1998, pp. 5-6), who concluded that 'buildings that integrate … features and attributes of biophilia … are more likely to be supportive of human health and wellbeing'. Candido et al. (2020) found improved satisfaction, productivity and well-being for workers in offices with plants, indicating the positive impact of biophilia. Nieuwenhuis et al. (2014) found greater satisfaction and perceived health in workers in offices that included the natural environment, enriched workspaces, improved air quality, and reductions in air-borne pollutants.

The relationship between designed elements and occupant health is complex and challenging to measure (Sanchez, Ikaga & Sanchez (2018). To understand this complex environment, Sanchez, Ikaga & Sanchez conducted a study to test a tool to objectively quantify the factors – such as biophilia and natural light – that affected occupants' well-being, performance and health. The study found that greenery and daylight played a key role in occupants' health and cognitive function (Sanchez, Ikaga & Sanchez 2018). In contrast, a study of 841 employees using two surveys over a year found limited connections between perceived nature exposure and employee well-being (Korpela et al. 2017). These authors recommended that providing free time for activity in natural environments would be an effective strategy for enhancing employee health.

Biophilic elements are being incorporated into the contemporary design of built environments. It is included in the WELL Building Standard and Fitwel Building standard as a key element of health-promoting environments (Candido et al. 2020; Xue et al. 2019). While the specific effects of biophilia in the office workplace are difficult to isolate, the benefits of plants to improve air quality and reduce airborne pollutants (Nieuwenhuis et al. 2014) are known. A recent review by Colenberg, Jylhä & Arkesteijn (2020) of seven studies relating to biophilia in the office showed mixed results, but none were negative. The research on biophilia reviewed here points to the positive impacts on health and well-being of incorporating biophilia, or biophilic elements, in office designs.

Influencing factors beyond the built environment

Health promotion and training

A salutogenic approach to health and workplace design takes a holistic view beyond the physical features of the interior built environment. There are many examples of well-designed indoor environments contributing to improved occupant satisfaction; however, the full benefits may not be fully realised without health promotion strategies (Brakenridge 2016; Maylor et al. 2018; Punnett et al. 2009; Robertson, Ciriello & Garabet 2013). Stokols (1992) details that any health promotion strategy needs to consider the complexity of built environments and the dynamic human interplay within those environments. For Stokols,

adopting a ‘social-ecological perspective’ is the best means of determining an appropriate health promotion strategy for any given context. Health-promotive environments link the physical health, mental well-being and social dimensions. For this linking, an interdisciplinary approach is required that engage the fields of public health and social sciences (Stokols (1992).The systematic review by Jiménez-Mérida et al. (2020) highlights the need to develop health promotion policies that consider the needs of each gender and the different effects of gender on health outcomes.

A design approach that incorporates macro-ergonomic interventions improves workers’ performance and reduces negative health impacts by providing a flexible physical workplace that accommodates the ergonomic needs of individuals and teams (Robertson et al. 2008). As part of a salutogenic approach, macro-ergonomics provides a framework combining physical and organisational elements to enable and promote individual health improvements (Punnett et al. 2009). Robertson et al. (2008) completed an extensive study in macro-ergonomics for office workers. Feedback and responses were collected two months before and three- and six-month after implementing an office ergonomics training program. Eight of the ten independent variables (workspace, lighting, collaboration, job control, ergonomic climate, corporate culture and communication) were significantly greater for the flexible workspace. The office ergonomics training was beneficial and had clear positive outcomes for those who undertook it, including decreases in Work-Related Musculoskeletal Disorders (WMSD). Aspects of ergonomics in the workplace include knowledge of ergonomic design principles, awareness of body postures and knowing where to find support. In a study by (Robertson et al. 2008), these aspects were positively associated with outcomes including a sense of community and job control.

A salutogenic approach to workplace health that incorporates health promotion can improve workers’ health and performance. In a quasi-experimental study with 57 office workers, Gilson et al. (2016) provided the intervention group with software that prompted them to stand up regularly from their seated position and with ergonomic training. Sedentary behaviour was reduced by a factor of four in the intervention group compared to the control group. A study by Maylor et al. (2018) examined the effects of training and education without physical changes to the office environment. Eighty-nine workers in 12 offices received the intervention over eight weeks. The intervention resulted in a significant reduction in prolonged sitting time. These results show that education and training are effective in changing sedentary behaviours.

The integration of health promotion or training with changes in the physical workplace effectively improves health outcomes (Bohr 2002; Gilson et al. 2016; Maylor et al. 2018; Robertson, Ciriello & Garabet 2013). Punnett et al. (2009) highlight the importance of an integrated approach to health promotion that includes the physical environment and

relevant supporting programs. With employee input and environmental changes, improved health and safety may be sustained over the longer term.

Participatory ergonomics

'Participatory ergonomics' includes workers' participation in the design process (Karwowski 1999). Hedge (2017) described a process whereby workplace designers drew on user experience and evidence-based research to create the optimal supportive environment. The resulting workplaces included ergonomic settings and equipment that supported each specific organisation's processes, activities, and tasks. This participatory decision-making method may create solutions that enhance workers' daily experience, productivity and health outcomes (Burgess-Limerick 2018; Punnett et al. 2009). Industries with diverse settings and needs have implemented ergonomic programs. For this reason, it is not possible to develop a single program that is effective in all organisations. Furthermore, ergonomic programs need to target diversity within a workplace, including workers from diverse backgrounds with diverse levels of expertise. Participation of workers in designing an ergonomics program ensures that the program will meet the needs of those workers in that workplace; for example, training in specific tools used.

A human-centred approach, such as participatory ergonomics, connects safety and health programs and empowers the workforce through their participation in designing their work systems, procedures and environment (Burgess-Limerick (2018); Punnett et al. (2009). Participatory ergonomics fosters greater ownership of the workplace problems, workers' commitment to the solution and improved perceived meaningfulness of work. The review of 23 studies by Rivilis et al. (2008) presented a balanced view of varied organisations with different group sizes, duration of training, participation of an ergonomist and team types. Rivilis et al. (2008) concluded the organisations engaging in participatory ergonomics generally reported fewer injuries, fewer workers' compensation claims and reduced absenteeism. In contrast, Bohr's (2002) study of 102 participants randomly assigned to traditional ergonomics education and participatory education found no evidence that workers positioned their work equipment more effectively when trained using participatory methods. Bohr (2002) recognised the need for larger sample sizes in such research and recommended that evaluation tools be developed for measuring the effectiveness of interventions, including ergonomics education.

Flexibility of hours and choice of work location

As part of a broader holistic approach, all factors and elements that impact employee health need attention. Policies such as flexibility of hours and location impact health outcomes (Hayman 2010; Hilbrecht, Smale & Mock 2014). With the development of mobile technology and increased demand for real estate efficiencies, many organisations are adopting flexible work policies related to both the hours of work and the location of work

(Hedge 2017). According to Nijp et al. (2016, p. 604), ‘time and place independent work’ varies considerably between organisations, depending on work activities, culture, technology and office location. Workplace flexibility, in the form of locational flexibility, has potential negative impacts, including increased stress due to more responsibility, loss of structure, blurring of the work-home boundaries and long work hours (Nijp et al. (2016). Nijp et al. (2016) completed a study of 2,300 participants from a Dutch financial company, investigating the effects of location and time flexibility on employee’s health and well-being. This workplace flexibility policy was implemented in an ABW office environment. It was supported by ergonomics training for desk and chair set up in the workplace, and employers received a financial contribution for adequate set up at home. Despite this flexibility strategy being well executed, self-reported health status was the only outcome that changed after the implementation, and that change was a decrease. No changes were found in workplace performance, satisfaction, or commitment.

In contrast, a study aiming to understand the relationship between flexible work schedules and employee well-being was completed by Hayman (2010) with 336 administrative workers at an Australian university. The results differed from those of Nijp et al. (2016) because flexible hours and time working from home enhanced personal life and time at work. The results suggested that flexible working contributed to employee well-being through better work-life balance. Similarly, Hilbrecht, Smale & Mock (2014) found that flexible hours allowed workers to control the timing of their commute and the times that their workday started and finished. As a result of this flexibility and control, commuting times could be minimised, increasing opportunities for engagement in physical activity.

A consequence of work location flexibility may be that workers do not have adequate ergonomic support throughout their working day (Hedge (2017) since ergonomic design principles implemented in the workplace may not be implemented in workplaces outside the office. Potential negative consequences of lack of boundaries between work and home life (Nijp et al. 2016) and unsuitable ergonomic practice at home have been highlighted by the COVID-19 pandemic (Davis 2020; Johnson 2020; Meister 2020; Öste 2020). However, these negative impacts of flexibility could be counterbalanced by improved quality of life, as indicated by the Hayman (2010) study. In response, employees' health promotion and education in managing flexibility have become of paramount importance as part of an overarching salutogenic framework for workplace health.

Active commuting to work

The ability to actively commute to work and access ETF and gym facilities may be important for a healthy workplace. If the office environment itself limits healthy activity via sedentarism, other work-related elements become more important. This is reflected in the assessment criteria of the health-focused standards and environmental standards

discussed in the following chapter. The WELL and Fitwel Standards promote active commuting via credits for building a building that enables active commuting or end of trip facilities (McArthur & Powell 2020). Commuting impacts health in two ways: firstly, commuting time impacts the time remaining for potential leisure activities; and secondly, commuting can include physical activity (Hilbrecht, Smale & Mock 2014). Integrating increased physical activity with daily life is necessary to counteract the effects of workplace sedentarism (Chau et al. 2014; Hilbrecht, Smale & Mock 2014; Page & Nilsson 2017). However, active commuting is not commonplace. On the day of the 2016 Australian Census, only 5.2% of the 9.2 million commuters cycled or walked to work (Australian Bureau of Statistics 2016). Active transport as a mode of commuting is limited to a very few.

A five-year study by Blake, Zhou & Batt (2013) of more than a thousand NHS workers found that promoting the health benefits of active commuting increased participation. A multi-level workplace wellness intervention that included health promotion increased the number of respondents actively commuting to work. In addition, at five years post-intervention, more respondents met government recommendations for physical activity than at baseline. Similarly, Page & Nilsson (2017) compared active and passive commuters in a small organisation and found that active commuters reported better physical health and were more productive than passive commuters. The systematic review by Oja et al. (2010) of research comparing active transport (such as walking and cycling) with passive transport (such as travelling by car or public transport), concluded that active transport resulted in improved daily step counts by users, and was associated with improvements in health factors such as cardiovascular fitness and reductions in cardiovascular risk factors. However, active transport is not an option for all commuters due to long distances and time constraints (Shannon et al. 2006). This points to the importance of an active workplace that can reduce sedentary time and incorporate physical activity into the work environment. Analysis of a data set of 3,409 commuters in Canada found that long commutes (average 53 minutes per day) were associated with poorer physical and mental health outcomes (Hilbrecht, Smale & Mock 2014). Some barriers to active commuting have been identified, including a lack of cycling infrastructure and perceived danger (Daley, Rissel & Lloyd (2007); Shannon et al. (2006)). Safety concerns are more likely to discourage women than men from actively commuting. In a Sydney study that found that 80% of commuters were male, heightened safety concern was cited by female participants as the reason for the gender difference (Daley, Rissel & Lloyd (2007).

Discussion of literature review

This chapter reviewed the evidence for the primary elements, strategies or practices that impact the health status of office workers and will inform the methodology of this research.

While elements have been reviewed individually in this chapter, work environments and individuals' responses are multidimensional and complex (Stokols 1992). Stokols (1992) postulates that analysis of health-promotive environments needs an ecological perspective grounded in 'a contextually orientated view of human health and wellbeing' (Stokols 1992, p. 7). This ecological perspective recognises the interconnections and relationships of all parts of the environment, including the humans that dynamically interact within it.

The components of indoor environment quality (IEQ) access to daylight and lighting appear to be the most significant factors impacting occupant health with implications for sleep quality and duration (Boubekri et al. 2014; Das 2015; Figueiro et al. 2017; Mills, Tomkins & Schlangen 2007; Romm & Browning 1994). Poor air quality impacts occupant health (Rasheed, Khoshbakht & Baird 2021), resulting in increased absenteeism and reported respiratory conditions (Nriagu 2011; Singh et al. 2010; World Green Building Council 2014). Indoor temperature and noise impact comfort and satisfaction, which in turn impact health (Bergström, Miller & Horneij 2015; Colenberg, Jylhä & Arkesteijn 2020; Roulet et al. 2006). Hence their effects on health are indirect (Candido et al. 2020; Herbig, Schneider & Nowak 2016; Kim et al. 2016). While these individual studies of individual elements are of value, we are reminded that the occupant does not experience each of these elements in isolation; therefore, a broader assessment of the total environment or ecosystem may be more appropriate for this current study.

Office work contributes to sedentary-related diseases (Chau et al. 2010; Owen et al. 2010; Parry & Straker 2013; Sugiyama et al. 2020; Thorp et al. 2014). To reduce the adverse health consequences of office work, interventions aimed at increasing physical activity and decreasing sitting time have been tested (Alfonsin et al. 2018; Engelen, Dhillon, et al. 2016; Pronk et al. 2012; Zimring et al. 2005). The use of HA workstations to counteract the effect of prolonged sitting on musculoskeletal discomfort and disability has been extensively researched (Karakolis & Callaghan 2014; Robertson, Huang & Larson 2016). HA workstations have been found to reduce prolonged sitting, musculoskeletal discomfort and increase energy expenditure (Tudor-Locke et al. 2014); further, no harm has been identified for workers using HA workstations. One common theme of many of the studies relating to HA workstations is the framing around risk mitigation and reduction of harm of prolonged sitting rather than framed from a health-positive or proactive viewpoint.

Active workplaces encourage workers to be physically active by designing physical workplace features and organisational strategies that promote movement (Engelen, Dhillon et al. 2016; Engelen, Dhillon, et al. (2016); Jancey et al. (2016). The inclusion of internal stairs in a workplace and organisational strategies to encourage their use have positive health benefits (Engelen, Dhillon, et al. (2016); Jancey et al. (2016) Meyer et al. (2010); and Zimring et al. (2005). However, the effectiveness of particular support strategies was

more varied. Rassia (2014) found that workplace design that placed stairs near attractive elements such as windows and views promoted stair use, while Engelen, Dhillon, et al. (2016) found that motivational signage did not increase stair use. Supplementing the physical element with training and education improved health outcomes (Healy et al. 2013; Robertson et al. 2008), and integrating health promotion with physical design interventions is more effective than either approach alone (Bohr 2002; Gilson et al. 2016; Maylor et al. 2018). This integration of well-designed elements such as stairs with associated health promotion is a compelling example of the need for a holistic multi-faceted approach to maximise health benefits for office workers.

Layouts and office types can also impact health outcomes (Danielsson & Bodin 2008; De Croon et al. 2005; Herbig, Schneider & Nowak 2016; Khoshbakht, Baird & Rasheed 2021; Pejtersen et al. 2011). For example, Bergström, Miller & Horneij (2015) found that sick leave taken increased with the number of people with whom a worker shared an office. As a note of caution, sick leave studies reviewed in this chapter that relied on only self-reporting may be influenced by recall bias (Pejtersen et al. 2011). It is also difficult to ascertain which element(s) of the office ecosystem is attributed to the absence or is related specifically to the individuals' own health.

Workplace policies such as flexibility and strategies such as ABW impact health outcomes. Some studies identified adverse impacts of flexible hours and location due to the 'blurred lines' between work and home life (Nijp et al. 2016). However, other studies found positive indirect health impacts, such as less commuting time and improved work-life balance (Hayman (2010) Hilbrecht, Smale & Mock (2014). (Rasheed, Khoshbakht & Baird 2021) also suggest that less time spent in the office may reduce the health impacts of this indoor environment and elements such as air quality and noise. The adoption of ABW has been shown to positively impact health by reducing sedentary time (Foley et al. 2016; Kim et al. 2016) and permitting workers to choose spaces that best suit their environmental comfort (Kim et al. 2016). While the impact of policies such as workplace flexibility and ABW have been presented, integrated well-designed office settings are equally important in a health-promotive ecosystem.

Many studies reviewed had methodological shortcomings that weakened their validity and generalisability. Such shortcomings include the lack of a control group, small sample sizes, and short timeframes (Alkhajah et al. 2012; Chau et al. 2010; MacEwen, MacDonald & Burr 2015). These shortcomings have led multiple researchers to recommend that future research be conducted with greater rigour (Neuhaus, Healy, et al. 2014). Measurement of many office workplace elements and their impact on occupants requires measurement tools that can be benchmarked or permit comparison with workplaces in other studies. Torbeyns et al. (2014), Bunn (2016) and Heerwagen et al. (1995) discuss the difficulty of

comparing studies due to differences in measurement techniques. Similarly, identifying and measuring health impacts and the variable occupant response to dynamic elements, is also complex (Baird, Rasheed & Wareing 2018; Hedge 2017; Mujan et al. 2019; Seddigh et al. 2015; Wolkoff 2013). A tool that captures a snap shot of occupant health beyond measures of step counting or standing time may provide the more wholistic and comparable score of occupant health status.

Stokols (1992) suggests the ecological perspective engages varied methodologies from questionnaires to observations. This holistic assessment may be suitable for studying the office ecosystem and the impact on occupant health. Measuring health status and generating comparable evidence is critical to creating positive health workplaces (Colenberg, Jylhä & Arkesteijn 2020). Studies reviewed used limited and singular measurement for assessment such as sitting time (Alkhajah et al. 2012) or energy expenditure (Tudor-Locke et al. 2014) which may not provide a wholistic or overall view of individual health status. Therefore, the next chapter focuses specifically on measurement tools for individual health status and rating tools of the built environment, including office workplaces.

Summary

This review illustrates that much of the current research is siloed and focused on the negative impacts of individual elements of the workplace. There is a need to reframe the study and implementation of workplaces to be more positive and holistic from the outset. Much research in workplace health has focused on preventing health problems rather than enhancing health (Colenberg, Jylhä & Arkesteijn (2020). Punnett et al. (2009) provide an example of how a holistic, integrated approach to physical workplace design, health promotion and workplace policy can positively impact occupants' health outcomes. In addition, Stokols (1992) identifies the importance of addressing the multidimensional and complex nature of built environments and the associated human interactions and responses. To fully leverage the benefits of the physical office environment for workers' health, health promotion needs to be incorporated into workplace implementation (Bohr 2002; Brakenridge 2016; Bohr (2002); Gilson et al. (2016) Brakenridge (2016); Maylor et al. (2018).

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Chapter 4 Measuring health in the office workplace

Introduction

Few independent evaluations of the effect of the office workplace on employees' health and associated productivity have been conducted, and few reliable measurement tools have been developed that would permit comparison between proposed and built projects. (Aristizabal et al. 2019; Foster & Hillsdon 2004; Hanc, McAndrew & Ucci 2019). A pathogenic framework underpins many tools, including POE tools, tending to evaluate the impacts of individual environmental elements (Trowbridge, Worden & Pyke 2016). However, reorienting workplace health to promote and enable health requires identifying and measuring salutogenic resources in the office workplace. Studies reviewed in the previous chapter have identified limited standardised tools for measuring health status in the office workplace context (Hanc, McAndrew & Ucci 2019; Zimring et al. 2005). A standardised measurement tool is required to measure the effects of individual workplace elements on office users' health, as well as their perceptions of any health benefits of particular interventions (Bluyssen et al. 2011). A measurement instrument that combines a standardised health tool with specific questions relating to workplace elements from a salutogenic perspective is required to achieve this. Such an instrument will help generate comparable data.

As the purpose of this research is to investigate the relationship between elements in the office workplace and the impact on office workers health status, the most appropriate and effective tools for data collection are considered. It is prudent to review existing qualitative and quantitative tools for measuring occupants' health and the physical workplace environment itself to identify the most appropriate tool for the research reported here. This chapter will firstly review the key tools employed to measure various health status indicators associated with workers. Following this, industry-recognised occupant evaluation surveys and health rating tools will be introduced. Finally, the rating systems developed to assess the functioning built environment will be briefly discussed, focusing on how health is treated in those rating systems. An understanding of the health and environmental elements these tools measure in practice and their strengths and limitations will help to identify the most appropriate, practical and universal tool to consider for use in the current study.

Measuring health in the workplace

Researchers investigating office workers' health have used various questionnaires to collect qualitative and quantitative data from occupants of workplaces (Vischer 2008). Definitions of health and well-being are inherently broad and multidimensional, making it difficult to measure, evaluate and compare the results of different studies (Hanc, McAndrew

& Ucci (2019). A 2015 review identified 60 health assessment measures, both uni-dimensional and multi-dimensional (Lindert et al. (2015). Health assessment tools cover a range of health dimensions, including physical activity assessment, measurement of workers' ability to perform expected tasks and evaluation of musculoskeletal complaints in the workplace. Terwee et al. (2016) argue that work ability, health and well-being cannot be measured objectively with one instrument alone. Researchers have often used several instruments, a combination of instruments, or developed a specific tool to measure the outcome (or outcomes) of interest. Given the wide range of factors (and their interactions) that contribute to health in the office environment, the varying definitions of health, and the lack of standardised measures, a novel measurement tool was developed for this research. This novel tool was a good fit for the specific context and salutogenic approach. The tool integrated a standardised health tool with a set of questions to investigate whether a specific workplace was health-positive from a salutogenic perspective.

Health-related assessment surveys and tools

A number of objective and subjective methods were potential candidates for measuring health-related outcomes and the workplace factors that influence them. The use of objective measuring devices, such as accelerometers has become increasingly common. Due to improvements in technology, heart rate monitors and several types of activity trackers have become increasingly easy to use and provide accurate data. These devices are often used in conjunction with questionnaires to confirm the accuracy of self-report data (Bluyssen et al. 2011; van Nassau et al. 2015). Two major Australian studies using both devices for objective biometric and behavioural measures and questionnaires are Brakenridge (2016) Lendlease study and the Telstra study by Mackey, Engelen & Foley (2015). Some biometric devices are not well suited to field research because they require laboratory testing and expensive diagnostic equipment. The methods chosen for this study needed to be robust and able to be implemented with available resources and be acceptable to participants (Hakkarainen, Ketola & Nevala (2011). While these studies are informative with validated data, a broader understanding of individual health status is difficult to ascertain.

As the relationship between indoor office workplaces and occupants' well-being is complex, subjective measures are required that can measure relevant elements such as physical stressors and individual health factors (Bluyssen et al. (2011). When considering the most appropriate tool for measuring perceived health in the workplace from a salutogenic perspective, components of existing self-reporting tools were potentially relevant. Existing tools or questionnaires may require additional questions to collect specific data (Bluyssen et al. 2011; Hanc, McAndrew & Ucci 2019; Lindert et al. 2015). As this study used a salutogenic approach, the Salutogenic Wellness Promotion Scale (SWPS) was considered.

Becker (2009) tested the validity of the SWPS with 2,140 university students, and their performance (using Grade Point Average) and perceived health (health was defined using the WHO's characterisation). Data were collected over two semesters, and participants were asked to rate their perceived health on a 25-item instrument. Health-related questions were rated by respondents using a Likert scale. Questions covered engagement in health-promoting actions related to the physical, intellectual, social, emotional, spiritual, vocational and environmental domains. Despite the results confirming the reliability of this measurement tool, further research is required to replicate these findings. While the SWPS considers salutogenic and pathogenic factors, it does not appear to have been used in Australia, which may limit comparisons or benchmarking in this jurisdiction.

A tool that has been widely used to measure health status is the SF-12. This instrument is a short-form version of the SF-36, the reliability of which has been established (Sanderson & Andrews (2002); Ware, Kosinski & Keller (1996). Sanderson and Andrews cross-validated data from 17,000 respondents from the 1995 Australian National Health Survey (Sanderson & Andrews 2002) by comparing two sets of physical and mental scores against Australian and US normative data scoring. The results indicated that SF-12 predicted at least 90% of the variance in both the physical and mental scores on SF-36, supporting the use of SF-12 as a valid short-form tool. Jenkinson et al. (1997) concluded that the SF-12 improved on SF-36 due to the reduced length while remaining an effective and meaningful measure of health.

A study of 500 workers in the UK public sector conducted by Wynne-Jones et al. (2009) used three scales, including the SF-12, to assess the relative impact of health, work characteristics and perceptions of work on absenteeism and performance. The study found that absenteeism and performance were associated with physical health (measured by the SF-12 physical scale) to a greater extent than mental health (measured by the SF-12 mental health scale). Another example of health measurement of office workers is a study by Meijer, Frings-Dresen & Sluiter (2009) that investigated the general health, fatigue and productivity of office workers who moved to an open and flexible workplace. Using the SF-36, this longitudinal study collected before-move and after-move health data from 350 people. Over the longer term (15 months after the move), perceived health improved over baseline data ($p = 0.011$). As several interventions were implemented in this study, isolating the influence of specific variables is difficult.

A study by van den Berg et al. (2008) aimed to identify the impact of office work on a sample of 1,141 office workers. Health-related outcomes were measured during a medical examination using the SF-12, the WAI and objective physical measures. Mental health scores were most influenced by work-related factors, while lifestyle factors outside the workplace most influenced physical health scores.

The SF-12 health status tool has been used in more than 130 studies to broadly describe the Australian population and their health-related quality of life (Tucker, Adams & Wilson 2010). The SF-12 includes questions that are easy to understand (Le Grande et al. (2019); for example, questions about physical activity levels include activities such as vacuuming or walking up stairs, rather than other measures of fitness such as a timed run or a fitness test. The terminology is also straightforward. For example, response options available on whether the respondent is experiencing pain include ‘not at all’ or ‘quite a bit’, wording which individuals may use in general conversation. The short length of the survey minimises the time required for completion, thus minimising disruption to the working day (Le Grande et al. 2019; Ware, Kosinski & Keller 1996).

Industry assessment and rating tools

Environmental rating and benchmarking of the built environment, including office workplaces, provides the property industry, building owners and occupiers with information to inform decision-making about a property’s environmental and operational performance (Candido et al. 2016). Three key learnings for measuring and improving office workers’ health status arise from considering existing building rating systems (Trowbridge, Worden & Pyke 2016). Firstly, well-established environmental rating systems such as Green Star, provide a foundation upon which a health-focused rating system can be built. Secondly, evidence from existing building rating systems shows that buildings with high environmental ratings have higher occupant satisfaction and perceived health responses (Al Horr et al. 2016; Roulet et al. 2006). Thirdly, site data standardised for environmental rating system assessment, if available, is valuable for occupant studies as it provides context and comparison with other rated sites.

Industry-endorsed tools, such as Green Star and NABERS, assess and rate the quality and environmental performance of built projects, including office buildings that accommodate office workers. Buildings themselves can be assessed and rated for their environmental credentials, operational efficiencies and – most relevant to this study – health and well-being impacts. Although the links between the built environment and public health are now well-established, industry decision-makers lack the knowledge and measurement tools to improve employees’ health through workplace design (Trowbridge, Worden & Pyke 2016). Measurement of green building performance has been dominated by engineering and efficiency standards rather than measuring the holistic impact of the built environment on the natural environment (Xue et al. (2019). However, recent studies by Liang et al. (2014) and (Lee et al. 2020) indicate that environmentally certified buildings rate higher on satisfaction with IEQ and health than conventional buildings. The range of industry-recognised assessment and rating tools for office buildings and their occupants in Australia

is small. As a result, the opportunities to collect, analyse and benchmark relevant data are reduced.

Post-occupancy evaluation (POE)

Most rating systems require surveying building occupants. This process, known as post-occupancy evaluation (POE), provides insight into the IEQ that affects occupants' health and well-being. POE uses data collection methods such as occupant questionnaires and physical measurements (Vischer 2008). POE instruments generally have few questions that specifically address health impacts. Greater use of health-related questions in POE would permit the generation of a health score suitable for comparison (Trowbridge, Worden & Pyke 2016). POE data on occupants' experience of a built project is beneficial for assessing the extent to which the outcomes intended at the design phase or certification stage have been achieved. In addition, occupants' POE responses determine whether a building performs as anecdotally reported (Li, Froese & Brager 2018). Selection of the most appropriate POE tool is generally related to the geographical location of the site. For example, the BOSSA tool may be most suitable for Australian projects, as it was developed in Australia and contains an extensive database of Australian projects.

POE methods include self-report questionnaires, interviews and physical measurement. Questionnaires were the most popular data collection method in 81% of all projects reviewed from 2010 to 2017 by Li, Froese & Brager (2018). Objective measures include sensors to measure variables such as humidity, temperature, illuminance and acoustics. Li, Froese & Brager (2018) identified 16 existing POE tools from which they developed a POE protocol which they believed would be useful globally. The authors suggest that the lack of a universal POE system may be due to a large number of features for possible inclusion in a POE, stemming from the uniqueness of built projects, varied geographical contexts, and differences in building codes, regulations and occupant expectations.

The UK-based POE tool, BUS Methodology, was developed in 1995 for use in the design, construction and operational stages of both residential and commercial projects (Building Use Studies Methodology (BUS) 2017). It has collected 850 datasets across the globe and can be used for environmental ratings such as LEEDS, WELL and NABERS, discussed later in this chapter. Another rating system is the widely recognised Occupant Indoor Environmental Quality Survey created in 1997 by the Centre for Built Environment (CBE) at the University of California (Berkeley) (Li, Froese & Brager 2018). Candido et al. (2016) have identified the need to improve existing POE tools by contextualising individual site results, creating uncomplicated and straightforward feedback for industry associates, and supplementing objective instrumental data.

BOSSA, an IEQ assessment system for office buildings, was launched in 2011. The occupant survey component of BOSSA is the most commonly-used data collection system for assessing occupant satisfaction within NABERS, Green Star and WELL Building certification. At the end of 2020, 143 projects had executed BOSSA yielding 172,231 individual responses to the occupant survey (L.Thomas, personal communication, April 22, 2021). BOSSA was developed by built environment researchers at the University of Sydney and the University of Technology, Sydney, in conjunction with commercial property industry associates. This survey tool is intended to quantify the occupant experience, comfort and usability of the space. BOSSA's occupant survey includes one question rating how the workplace influences health. Although meta-analyses using the BOSSA database have been published, the raw data is not available to industry for analysis to inform project design.

No POE tool could be identified that collected adequate data on perceived health, so existing POE surveys were not considered for this study. Some relatively new assessment and rating systems consider the impact of the built environment, including office workplaces, on individual health, and these are considered below.

Health rating systems for workplaces

In 2017, Jones Lang LaSalle, a global real estate organisation, produced an event and publication titled 'The Human Revolution', which presented the view of industry leaders and professional bodies on the ideal workplace of 2030 (Jones Lang LaSalle 2017). The event emphasised the importance of health and well-being to future workforce productivity. Real estate solutions need to respond to the 'wellness movement'. When surveyed, participants indicated that the 'wellness movement' and a concomitant focus on physical health and well-being would significantly affect the way people work over the coming decade (Jones Lang LaSalle 2017).

The focus on occupants' health, rather than primarily on the design of the built environment, has generated demand for health-centric assessment and certification tools. Two health-based ratings and independent assessment systems used in Australia allow organisations to obtain third-party certification. These health-focused systems are WELL and Fitwel, which will be discussed below. A potential strength of these third-party certifications is the requirement that policies and procedures be developed for the building's ongoing operations. This ongoing attention creates an opportunity to enhance the health aspects of the original building design (Candido et al. 2020). The shift towards a focus on occupant health (rather than simply environmental certification) is illustrated by the fact that both WELL and Fitwel systems provide credits for building designs that promote outdoor physical activity and use ergonomic design within the office (McArthur & Powell 2020).

WELL Building Standard

The WELL Building Standard, launched in 2013 in the United States by the International Well Building Institute (IWBI), explicitly assesses and rates the health and well-being of building occupants. Globally, 8,970 projects are registered with WELL, and 421 projects are WELL-certified (International WELL Building Institute 2021). Ten areas that impact occupants' health and well-being are assessed under Standard Version 2; these include movement, comfort, mind, and nourishment. The Standard also addresses traditional assessment criteria such as air, water and light quality (Hedge 2017). Table 4.1 summarises the standard relating to the built environment and the rationale for improving the health outcomes of occupants. The concepts and elements are broad and provide a holistic framework for the assessment and relate specifically to health in the workplace.

Table 4.1: WELL Building Standard and health rationale

Standard/concepts in WELL v.2	Components included	WELL rationale for health promotion
Air	Features include air quality, ventilation, opening windows	Minimise exposure to contaminants harmful to occupants
Water	Features include water quality, distribution and control of water in a building	Ensure adequate hydration of occupants and offer an alternative to sugary drinks
Nourishment	Operational policies to improve the availability of fruits and vegetables and nutritional information on offerings in and around the workplace	Encourage healthy choices by increasing access to healthier food and beverage options
Light	Promotes exposure to light that is optimal for visual, mental and biological health	Correct lighting and access to daylight can improve sleep quality and reduce circadian phase disruption
Movement	Environmental design strategies, programs and policies that promote movement	Promoting movement and reducing sedentary time can have positive health benefits
Thermal Comfort	Improved heating and ventilation system design and control to optimise the thermal comfort of occupants	Thermal comfort and the ability to control it can impact occupant perceived health
Sound	Control and mitigation of noise within the workplace and fixed acoustical comfort parameters	Reduction in excessive unwanted noise and comfortable acoustic levels can instil a sense of well-being

Standard/concepts in WELL v.2	Components included	WELL rationale for health promotion
Materials	Feature includes identification, evaluation and management of hazardous materials, from building finishes to cleaning products	Reducing and limiting exposure to harmful chemicals and gases is essential to good health
Mind	Addressing the mental health of occupants through policy, programs and design strategies outlined in the Standard	To support cognitive and emotional health through a variety of prevention and treatment efforts
Community	Promotion and education of the health benefits and strategies for those living and working in the subject spaces, including communication and messaging	Evidence suggests education and promotion of health-promotive workplace features will improve health outcomes

Reference: (International WELL Building Institute 2018, 2021)

Unlike other standards that focus on the building and its design, systems, and energy efficiency, WELL focuses on the occupant experience and the building's health impact (Hedge 2017). Concepts presented in this health-centric standard such as Movement, Thermal comfort and Light have been considered for inclusion for assessment in this current study. WELL is also known to be the most prescriptive of all standards (McArthur & Powell 2020), having strict guidelines and thresholds to achieve credits for certification. Young (2016) notes that WELL assessment criteria are based on seven years of peer-reviewed medical and scientific research. Certification can be applied to three property types: new and existing buildings, new and existing interiors, and base building and single tenancies (Young 2016). Candido et al. (2020) analysed nine offices in Australia certified by GBCA, two of which were also WELL-certified. The highest scores for overall satisfaction, work ability and health were reported on WELL-rated sites. Despite the relevance of the WELL rating system to workplace health, it is of limited use to industry because IWBI does not make WELL data publicly available. Fitwel is another standard that shares WELL's focus on health outcomes and has many similar components.

The Fitwel Standard

Another health-focused rating tool is the recently-established rating system, Fitwel, developed by the US-based Centre for Active Design (CfAD). Fitwel was designed to address the impact of the built environment on health. Fitwel rates various attributes that encourage movement or physical activity. This contrasts with other more prescriptive standards that have separate credits for designed elements such as accessible and visible stairwells (McArthur & Powell 2020). Fitwel is less prescriptive on specific elements and narrower in scope than WELL. Its central focus is on IAQ, enabling activity and social

wellbeing (McArthur & Powell 2020). Like the Australian-based rating tool, BOSSA, Fitwel was developed by public health researchers and property stakeholders and piloted in the US by the General Services Administration (GSA). A shortcoming of both WELL and Fitwel is that some elements are not relevant outside US conditions and laws. For example, the Fitwel standard requires specific signage promoting 'No Smoking' zones that, in Australia, would be unnecessary, as such areas have a blanket non-smoking designation by law. Attributes in Fitwell most relevant in Australia include location, outdoor and indoor spaces, stairwells, shared spaces and workspaces (Table 4.2).

Table 4.2: Fitwel Standard attributes description and rationale)

Fitwel Attribute	Description	Rationale for health promotion
Location	Address of the office is assessed by using the Walk score program to illustrate access to public transport	Location of workplace impacts commuting times and opportunities for active transport, such as walking and cycling
Building Access	Accessibility of pedestrian route to the main building entrance, end-of-trip facilities with bike parking and amenities, parking for carpools	Opportunities for active transport and physical activity may reduce morbidity and absenteeism e.g. walking from bus or train station or cycling from home
Outdoor Spaces	Access to outdoor spaces with amenities such as shade, fitness equipment, walk trails; including no-smoking policies	Increased opportunities for physical activity reduces morbidity and absenteeism and instils feelings of well-being
Entrance & Ground Floor	The main entrance is oriented for pedestrian access, is smoke-free, disability-accessible, well-lit and well-maintained	Promotes safety, instils feelings of well-being, increases physical activity, reduces morbidity and absenteeism and impacts community health
Stairwells	Accessible internal stairs allow for more physical activity during the workday. Adding signage to encourage use	Increases opportunities for physical activity, instils feelings of well-being and reduces morbidity and absenteeism
Indoor Environment	IEQ includes no smoking, limiting exposure to hazardous materials such as asbestos, manage ventilation, limit volatile organic compounds (VOCs) in materials used	Instils feelings of well-being, reduces morbidity and absenteeism and supports social equity
Workspaces	Access for all to daylight, views of nature, HA workstations, control of daylight or sun	Instils feelings of well-being, reduces morbidity and absenteeism and increases physical activity

Fitwel Attribute	Description	Rationale for health promotion
Shared spaces	Shared and amenity spaces throughout the workplace should be clean, promote hygiene, encourage communal breaks. Access to quiet and private rest areas, multi-purpose rooms for wellness activities, gyms	Instils feelings of well-being, increases physical activity, reduces morbidity and absenteeism and supports social equity
Water Supply	Readily accessible drinking water and points for refilling to encourage regular consumption	Provides water instead of sugar-sweetened drinks
Food Services	Offering healthy nutrient-dense food and drink options, incentivise healthy food selection and pricing incentives for healthy food offerings	Reduces morbidity and absenteeism, instils feelings of well-being and provides healthy food options
Vending Machines	Requirements to provide healthy food and drinks and price incentives to encourage healthier consumption choices	Reduces morbidity and absenteeism, instils feelings of well-being and provides healthy food options
Emergency procedures	Database and reliable management of emergency equipment to respond to employee safety during emergencies	Promotes safety and reduces morbidity and absenteeism

(Reference: Center for Active Design (2020)

The Fitwel standard has limited peer-reviewed research; therefore, the information provided here is based on published content from the Center for Active Design (CfAD) website (Center for Active Design 2020). Globally, 2,100 projects are registered with Fitwel, and 700 are Fitwel-certified (Center for Active Design 2020). As at April 2021, three Australian office workplace sites, in Sydney and Brisbane, are Fitwel-rated (Center for Active Design 2020); these numbers are too small to permit benchmarking or comparison. Despite these limitations, the Fitwel Standard is relevant because of its lower cost and not-for-profit administration, potentially leading to faster market adoption than the WELL rating system.

The Fitwel and WELL standards focus on workplace elements that foster the health of building occupants, including office workers. However, ongoing research of case study projects that are Fitwel or WELL certified is essential to understand if real change and improved health outcomes have been achieved in practice.

Attributes from Fitwel such as stairwells and workstations have been adopted for inclusion in this current study.

Building rating systems

Alongside health rating systems that focus on those living or working in the built environment, similar rating systems exist to rate the building as a whole. Rating tools for base buildings that house office workers may impact the health of occupants. A systematic review of sustainable building ratings and health ratings found significant consistency (McArthur & Powell (2020). For example, while Greenstar, LEED, WEL and Fitwel systems all include the provision of daylight and access to daylight in their rating system, only Fitwel and WELL include health promotion and education (McArthur & Powell 2020).

Sustainable buildings provide a healthier and more comfortable environment for their occupants (Doan et al. 2017; Vischer 2007). Similarly, in a study of 12 green-rated and 12 conventional buildings, Leder et al. (2016) found that green-rated buildings offered occupants a superior level of IEQ, comfort, and satisfaction compared to conventional buildings. In support of these findings, a 2017 press release from the IWBI, *Health and Sustainability: No Longer an Either/Or Equation,* encapsulates the direct link between a sustainable building and the health of its occupants (International WELL Building Institute 2017). Health-promoting indoor office environments are beneficial for employers since workers' salaries and employment costs significantly outweigh building operational costs, creating an incentive for employers to maintain worker productivity through health maintenance (Bendewald et al. (2014); Fisk (2000); Nriagu (2011).

Almost 150 green building rating systems exist globally (Herda 2017). In Australia, a number of environmental rating tools are accepted by industry at the national level. These rating systems assess and rate buildings and their interiors from the design and construction phase to ongoing operational measurement. The aims of the GBCA's voluntary rating system include 'enhancing our health and quality of life' (Green Building Council of Australia 2021), yet detailed assessment of the impact of the built form on occupants' health is limited. The GBCA's Green Star rating tool commenced in 2003; it assesses and rates the environmental qualities and efficiencies of buildings in Australia (Green Building Council of Australia 2021). The GBCA states that 44% of office space in Australian central business districts is Green Star-certified, and 790,000 people live or work in a Green Star-rated office or housing development (Green Building Council of Australia 2021). GBCA assessments include four rating tools that measure the ongoing efficiency and operational performance of a building. The assessment applies credits for features including best-practice water efficiency measures, use of low impact or sustainable building materials, life cycle analysis and management practices that result in sustainable outcomes (Green Building Council of Australia 2021).

Another aim of building rating systems is to improve occupants' experience, comfort and well-being by rewarding specific design features of the interior environment. POE surveys,

such as BOSSA or BUS Methodology, are used to obtain occupants' responses. As part of the GBCA Green Star Performance assessment, several calculators provide the framework and criteria for the assessment. Criteria that directly assess and measure employee health and well-being are IEQ, light, comfort, daylight, views, thermal comfort and acoustic comfort (Doan et al. 2017).

An industry discussion paper from Jones Lang LaSalle (Jones Lang LaSalle 2015) nominates the NABERS and Green Star ratings as the dominant building rating systems in Australia. In 1999, NABERS was developed as the Australian Building Greenhouse Rating (ABGR) scheme to reduce emissions produced by the built environment by adopting an operational rating system for benchmarking. The instrument is focused on actual performance rather than designed features. The relevance of NABERS to health outcomes is highlighted by the Roulet et al. (2006) study which investigated 96 apartment buildings and 64 office buildings using a building checklist and occupant surveys and found a strong correlation between low energy buildings and higher positive ratings of perceived health and comfort.

LEED, which provides four rating levels, is a globally recognised rating tool developed in 1998 by the non-profit US Green Building Council (USGBC). The LEED rating is sometimes used to compare Australian projects to projects in other jurisdictions (Doan et al. 2017). More than 70,000 projects are LEED-certified globally, and approximately 20 are LEED-certified in Australia. Singh et al. (2010) undertook two case studies of people moving into LEED-rated buildings. They found that the improved IEQ contributed to reduced perceived absenteeism and overall improvements in reported health. Another study of 500 LEED-rated buildings concluded that the LEED-rated buildings reduced absenteeism and increased occupant productivity and employee well-being (Al Horr et al. (2016).

Summary

This chapter has presented the measurement tools used by researchers and industry to determine workers' health status. Associated assessment systems for the workers' buildings were also considered. The most effective tools for use in this research were identified. No single tool available to researchers, designers and industry professionals was appropriate for determining the effect of office workplace design on occupants' health (Aristizabal et al. 2019). Despite POE being an effective tool for documenting occupant's satisfaction and comfort, it is less effective for collecting data on specific health impacts (Aristizabal et al. 2019). However, the BOSSA POE survey tool examines several indoor elements such as spatial comfort, air quality, thermal comfort and individual workpoint that could be adapted for use in this study.

Currently, office workplace designers lack the tools for assessing the health and well-being of the workers whose workplaces they are designing. Despite tools measuring health outcomes being available, no practical, standardised, universal or recognised assessment for benchmarking and comparing office workers' health status exists. The proposed methodology will include adapting relevant assessment criteria to ensure the most appropriate data are efficiently collected to investigate the health impacts of various workplace elements from a salutogenic perspective. Using a salutogenic approach, this research will draw together key elements of existing POE tools and the SF-12 to understanding how the office workplace impacts occupants' health.

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Chapter 5 Methodology

The previous chapter reviewed approaches to measuring office workers' satisfaction, comfort, and health status and to rating the built environment itself. The literature review identified the need for greater rigour in research addressing the impact of the office environment on occupants' health and the need for greater awareness of the workplace environment as an ecosystem. The concept of salutogenesis has also been presented (Chapter 2) and how physical workplace design and organisational policy can create health-enhancing interior office environments.

This methodology chapter begins with descriptions of the research aims, theoretical framework, and rationale for conducting a case study using a mixed-methods design of the 'convergent parallel' type (Creswell 2011). A description of the case study organisation is then provided to contextualise the research. In this mixed-methods study, qualitative (site analysis; interviews) and quantitative data (survey responses) were collected and analysed; the procedures for this is described in detail. As is appropriate for a convergent parallel design, analyses from the qualitative and quantitative components of the study are integrated to provide an overarching interpretation. The chapter finishes by considering potential ethical issues in the research and how they were managed, followed by the researcher's reflective statement.

Aim and research questions

This study aims to use a salutogenic approach to investigate the relationship between elements and factors of the office workplace and their impact on office workers' perceived health status. This research aims to respond to the following three principle questions:

- Which environmental elements have the greatest effect on the perceived health status of office workers?
- What are the key factors to consider when creating healthy office workplaces?
- What are the key factors during the design process that limit the consideration of health-enhancing office environments?

Theoretical framework

Pragmatism

The theoretical perspective selected for this study is Pragmatism (Creswell 2011). Pragmatism emphasises the value of obtaining knowledge that is useful for shedding light on 'real world' phenomena. A pragmatic researcher 'combines empirical precision with descriptive precision' and can combine the micro and macro levels of a research project (Onwuegbuzie 2007, p. 383). A pragmatist approach to research design calls for a design choice driven by the needs of the research question, bringing together qualitative and

quantitative research methods as required ((Creswell 2011); Onwuegbuzie (2007). Tashakkori & Teddlie (2003) outline the links between pragmatism and mixed-methods research:

- Methodological choices are based on practical and applied research principles.
- Qualitative and quantitative research methods can be used together in a single study. In this study, qualitative interviews and site analysis provided context and detail, while surveys provided quantitative data to generate robust statistical data.
- Post-positivism and constructivism approaches can both be used, as discussed below.
- Responding effectively to the research question is more important than a specific philosophical worldview or specific method.
- Most important is the need to recognise the metaphysical notions of 'reality' and 'truth', as data collection is focused on perceived health.

Post-positivism and constructivist worldviews

This study incorporates both post-positivist and constructivist worldviews. Pragmatist philosopher John Dewey first raised the connections between Pragmatism and Constructivism (Hickman, Neubert & Reich 2009). The following factors that underlie the methodology of this study are based on a post-positivism (Creswell, 2011):

- Determinism, or cause and effect thinking: this study investigates the relationship between the workplace elements (cause) and perceived health outcomes (effect).
- Reductionism: by narrowing and focusing on specific variables.
- Detailed observations: site analyses of each of the before- and after-move workplaces were conducted, and data collected.
- Theories are testing and refined on an ongoing basis throughout the research process at the stages of data collection.

Constructivism is also part of the research design. Constructivism describes the subjective views, understanding and meaning of phenomena for individuals shaped by social interactions and individual backgrounds (Creswell 2011). Crotty (1998) points out that, in the constructionist view, 'meaning is not discovered but constructed' by people as they engage with their environment and interpret it. The varied perspectives of individuals, when aggregated, can generate broader patterns and understanding (Creswell 2011). The basis of this research is understanding individuals' perceived health within the context of their office workplace. This research may provide a holistic insight from participants that is both objective and subjective, therefore is considered constructivist.

Methodological approach

A case study using a mixed-methods design

A case study using a convergent parallel mixed-methods design was conducted for this research, drawing on both qualitative and qualitative data collection techniques, to understand the relationship between the office workplace and workers' perceived health. A mixed-methods approach was selected for this research to provide multiple insights into the context and ecosystem of the office workplace, to answer the research questions comprehensively and credibly (Bryman 2006).

The case study described in this thesis aims to overcome the methodological limitations of some previous research by making the following assumptions:

- The office workplace is an ecosystem of interrelated elements that are both physical and policy-based – all of which can impact health status. A study that goes beyond the individual physical elements could add value to this field.
- A case study methodology can illustrate the impact of the physical environment and other workplace elements or policies as a holistic ecosystem.
- A study of an organisation before- and after-move office workplace allows changes to be identified and compared between sites.
- A mixed-methods study allows for a more holistic view of the phenomenon than a single method alone, whether quantitative or qualitative. In this study, quantitative data are collected, including a standardised health status tool. Qualitative data are collected using interviews and site analysis.

A 'real world' case study methodology was chosen because it allows this study to directly address current practice in office workplace design. The case study was designed to understand the context at two time points: before and after an office relocation. By collecting data at these two time points, participants' understandings – and how they have changed across time – were captured. Before-move data were collected from the case study organisation – initially located across two office building sites – and from employees working in those buildings (Sites A and B). After-move data were collected from employees after relocation from these two initial sites to another building (Site C). Site analysis was conducted at the new building (Site C) before the employees were relocated there. Figure 5.1 summarises the stages of the case study research.

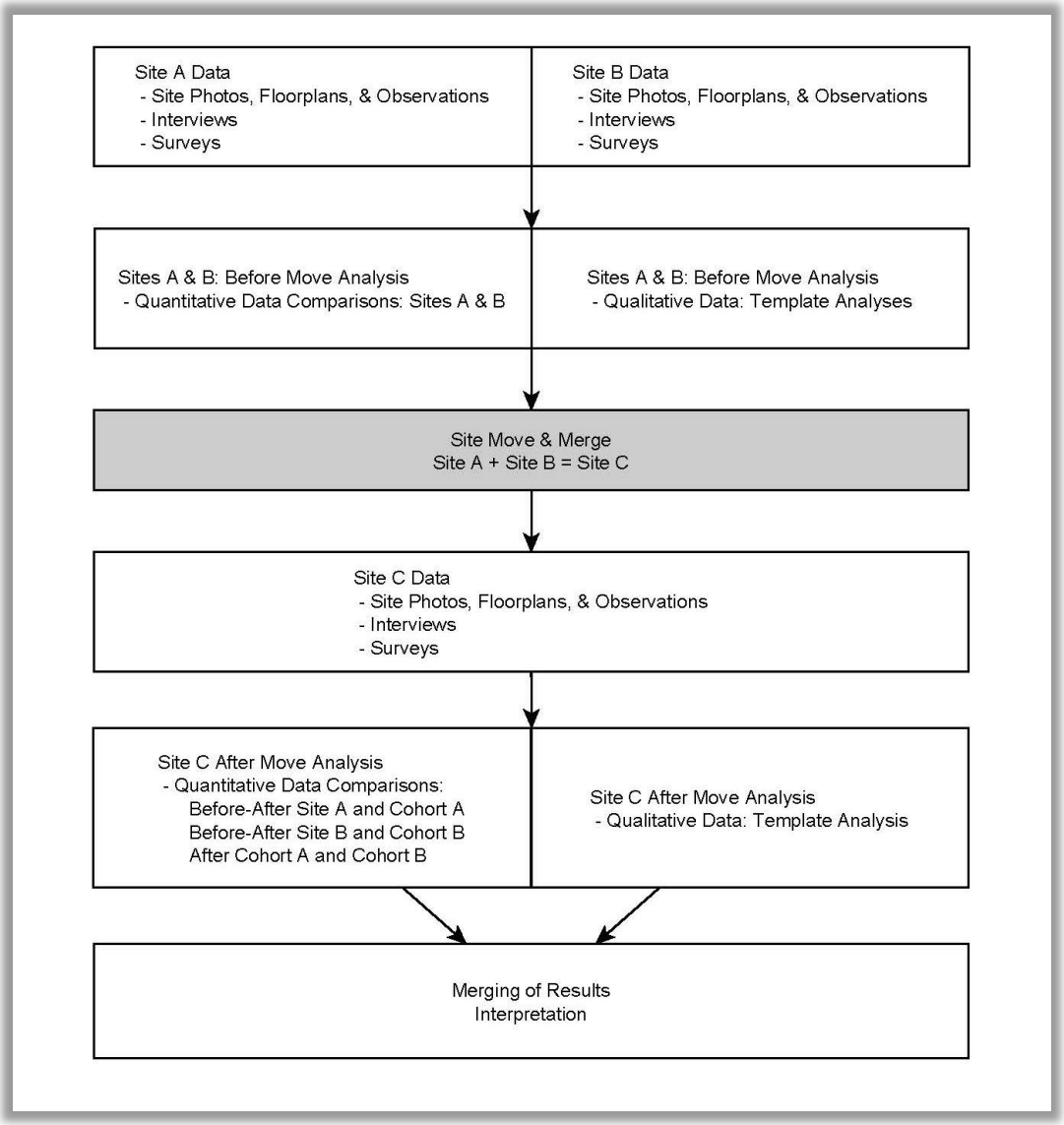

Figure 5.1: Stages of the case study

As a mixed-methods study, qualitative and quantitative data were collected. Quantitative data were collected as responses to the questionnaire. Qualitative data were obtained from site analysis and interviews with individuals involved in the design and management of the office workspaces at all three sites to gain insight into design intent and workplace implementation. These interview data contextualised the survey and site analysis data. The rich descriptions gained from participants' perspectives during interviews contextualised the quantitative survey data, thus bolstering the survey data's credibility (Brannen (2005). The perspectives of workplace designers, the project team and occupants, allowed for relationships and meanings from each data source to be exposed (Brannen 2005).

Convergent parallel design

The type of mixed-methods design used in this study is the 'convergent parallel design' (Creswell 2011). Qualitative and quantitative data are collected in 'parallel' and are analysed independently. The results of the analyses 'converge' by being synthesised into an interpretation of the results. The purpose of convergent design is 'to obtain different but complementary data on the same topic' (Morse 1991). In this case study, the rich qualitative interview data and the site environmental data complement, strengthen and contextualise the quantitative data of the survey. The central focus of this study is to investigate workers' perceived health as it relates to the elements of a larger ecosystem. Therefore, quantitative survey data were given 'quantitative priority' (Creswell (2011), meaning that greater emphasis was placed on the quantitative survey data than on the qualitative data. The qualitative interviews played a secondary role by framing and contextualising the survey responses.

Case study: An exploration of design and health in different office workplaces

This research investigated a single organisation as a case study to examine the interdependent elements and functions of the office workplace ecosystem. Case studies can be explanatory, descriptive or exploratory and are ideal as an architectural research method allowing data collection of the 'whole picture' (Niezabitowska 2018). Furthermore, an in-depth case study can capture context-dependent knowledge required for understanding the human response to environments (Flyvbjerg (2006). In the context of researching the influences of building design on physical activity, Zimring et al. (2005) suggest that a building case study enables the researcher to document design and implementation decisions.

The case study organisation

As this study aimed to identify changes in workers' health associated with workplace elements, an organisation based in Australia that was relocating offices was identified, thereby permitting before and after-move data collection. The case study site was selected because it met the requirements judged necessary to answer the research questions practically and efficiently:

- The organisation was willing to participate in the research, and the organisations' workplaces were accessible to the researcher.
- The organisation's employees were reasonably representative of office workers in Australia.
- Approximately 700 staff were available to participate in the research, sufficient to gain statistically sound data.

- Site data, such as floor plans and relevant building information, were accessible for the office spaces.
- The physical environment of the post-move office was reasonably typical of a contemporary office workplace.

Qualitative methods: site analysis and interviews

Site Analysis

The site analysis evaluated conditions such as daylight access, spatial layouts, settings layouts, thermal and air conditions, major designed elements and organisational information. Data included floorplans, layouts, site observations and photographs that 'set the scene' for the research. These were supplemented with BOSSA data (Building Occupant Survey System Australia (BOSSA) 2018a, 2018b). The site conditions and organisational information provided context and background to other research components (Brannen 2005; Candido et al. 2016), in this case, the survey and interview data.

The process for data collection during a site analysis was informed by guidelines for POE data collection (Li, Froese & Brager (2018) and by recommendations for collecting fieldwork documentation (Lucas 2016):

- Visit the before-move and after-move sites several times at different times of the day to observe any differences in usage and environmental conditions, such as sun penetration into the building floorplate.
- Date- and time-record notes and photos from the site visit.
- Record key elements, such as the desk types and stair access, as background for interviews and survey development.
- Using the floorplan as a reference, time-record site observations while walking through the workplace; remain static at different locations to observe how people are using the spaces at various times.
- Remain on site for two to three hours to observe any changes.
- Make use of time before and after scheduled interviews to sit in one location and observe workplace 'happenings' and occupants' use of space.

Following site visits, site data including photos, field notes, floorplans and existing BOSSA data (when available) were overlayed to develop a detailed and accurate 'picture' of the workplace conditions. The choice of data to be collected on aspects of the office environment was informed by POE tools such as BOSSA and a review of POE research by Li, Froese & Brager (2018) and Agha-Hossein et al. (2013). For example, survey items on IEQ were similar to those in BOSSA (thermal comfort and IAQ) and the WELL and Fitwel standards (Aristizabal et al. 2019).

A workplace's physical address can affect employees (Zimring et al. 2005) by, for example, influencing whether active transport modes are available. The 'walkability' of the offices' locations was measured using the 'Walkscore' tool, a 'measure of walkability' for any known address. This tool is part of the Fitwel standard assessment of location (Walkscore 2018). Walkscore is a US-based patented system that analyses any address and assesses its distance, or 'walkability', to amenities such as public transport. The more distant the amenities, the lower the score. A score of zero is given for distances requiring a walk of thirty minutes or more.

The objective of interviews with key informants

The purpose of gathering qualitative data via interviews with key informants (KI) was twofold: to provide insight into the workplace design intent and contextualise the survey and site data at the before and after-move workplaces. The after-move interviews focused on the philosophy and purpose underpinning the design of the after-move building and how this was realised. For this purpose, the perspective of decision-makers, most of whom were occupants, was sought. The aim was to provide a richer understanding of the design intent to complement and expand the survey results and site information. The KI interviews were conducted at both stages using a set of semi-structured questions.

Key informant selection and recruitment

The KIs were people directly involved in the design and implementation or ongoing management of the workplace, including facilities managers, interior designers, a workplace strategist, project managers, real estate professionals, IT consultants and internal management from various levels. External consultants were included as they could provide a somewhat independent view of the workplace. Participants were invited to be interviewed by the key contact within the organisation via email with information such as time required, expected interview content and purpose of the study.

Workplace teams that design and develop workplaces for organisations sized between 10 and 1,000 people are likely to have a project team of between five and 15 active members, depending on the stage and complexity of the project. Based on this information, ten KIs were selected for interviewing both before and after the move. The research contact person within the organisation was also interviewed to provide information about the workplace and building metrics. For reporting and data storage, each of the interviewees was labelled with a code composed of the following code units:

Table 5.1 Labelling of Interview data

Code unit	Interpretation of code unit
KI	Key Informant
#	Number assigned to interviewee
18	Represents 2018, the year of data collection
19	Represents 2019, the year of data collection

Interview protocol

Upon agreeing to be interviewed and a meeting time arranged, the proposed questions were sent to the participant via the organisational contact person. At the commencement of each interview, the purpose of the research and the interviews were explained, and the participant was given the participant information statement that included a clear description of present and future use of data. Before beginning the interview, consent forms were signed by the participant and the researcher. All interviews were audio-recorded and later transcribed.

Interview format and questions

Interview questions were designed to not only provide context for the study but provide further insight into the strengths and limitations of workplace design and the relationship of the workplace to occupant (Appendix C Before and after-move interview questions). The use of semi-structured interviews allowed for the exploration of topics or viewpoints. These included topics identified in the literature review pertinent to the design process, including the design implementation and responses to design features. Specific questions were asked at both the before- and after-move interviews to allow for comparison.

Depending on the interviewee's expertise or role, questions and prompts appropriate to that interviewee were selected from a more extensive list of questions and prompts. For example, external consultants were not asked about the organisation's response to employee health programs, as they would not know. The following describes the objectives and purpose of each set of questions and provides examples.

1.0 Opening general conversation

The opening part of the interview was a general conversation that covered the interviewee's background, their roles in the organisation and workplace, along with general information about the informant and their views.

Example prompts that were modified as required were:

Tell me about an average day or week for you?

Tell me about your role in the design, implementation [of the new office] or facilitation [daily operations] of this workplace.

The purpose of these opening prompts was to ascertain the person's role within their workplace, how long they had been part of the organisation, and their views on the workplace transformation process. General feedback about the after-move office provided information on the informant's level of engagement, depth of knowledge, broader responses to the workplace and whether they may have had any biases.

2.0 Employee health

Specific questions were asked to identify discussions and actions within the organisation about its employees' health and well-being and how workers' health and well-being were being measured. As noted previously, if the interviewee was external to the organisation or a question was not relevant to their role, it was not asked of that person. Sample questions were:

Do you discuss the health and well-being of employees in this organisation?

Are you proactively addressing employee health, and how are you doing this?

How are these policies being implemented and later measured?

Information was sought on the informants' knowledge and awareness of the organisation's programs and approach to employee health to gauge the organisation's commitment to and communication of relevant programs and policies.

3.0 Employee health and the workplace design

These questions aimed to understand the relationships between organisational priorities, consideration for employee health and awareness of factors that impact health. Sample questions asked at all sites and adapted for particular interviewees, were:

Was employee health a consideration in the design briefs?

How was employee health considered in the design of this workplace?

What elements do you think will make a difference to occupant health in this worksite?

This question was only relevant to those involved in the workplace's actual design and ongoing management. Background information and specific examples of how health was viewed in the workplace were also sought.

4.0 The workplace design and implementation process (after-move site only)

These questions aimed to understand how the workplace brief for Site C was developed and its association, if any, with occupant experience. Sample questions, modified as required for suitability for the particular interviewee, included:

Were there any specific health drivers, health-related issues or health policies discussed or prioritised in the design process?

How do you inform yourself of what works in terms of employee health?

These questions were only relevant to participants specifically involved in the design of the new workplace. The main information collected was the viewpoint of individuals on the elements or strategies that made a difference to people's health.

5.0 Gaps and shortcomings in current workplace design

The final part of the interview aimed to identify existing gaps in the implementation process and final design and to identify ramifications of these for occupants. Example questions that were modified depending on the interviewee were:

Can you identify any gaps or shortcomings in the process of designing and creating the workplace? Why do you think these gaps exist?

What design elements have changed since the old office that have a positive effect on occupants' health?

Finishing the interview with questions that prompt a more expansive discussion allowed the interviewee to share their own experience (and their colleagues, if known) and their views on what they believe impacts workers' health.

Interview analysis

Template analysis was used to analyse the data from the semi-structured interviews. Template analysis has evolved from more structured approaches such as Grounded Theory (Waring & Wainwright 2008) and is a highly flexible and interpretive process (King & Brooks 2017). Codes can be applied to the data depending on what is identified as important and can be edited as the content is further examined (Symon & Cassell 2012); Benaquisto (2008); DeCuir-Gunby & McCulloch (2001).

For analysis of the interviews, a series of formalised steps detailed by King & Brooks (2017) was used as a guide:

1. **Data preparation:** The interview audio recordings were transcribed by a commercial transcription service. Field notes taken during the interviews were checked and added to if required.

2. **Exploration:** All data related to a particular interview (transcripts, field notes and any other relevant data) were reviewed at a holistic level. For example, the informants' company biography or LinkedIn page were reviewed to provide possible insight into their perspectives.
3. **Analysis:** The content of the interviews was reviewed to establish background or design intent. Using the Template Analysis format described by King (Symon & Cassell 2012), key themes were identified and recorded for each of the transcripts. Some of these themes had been previously identified from the literature review, and others were discovered during the interviews.
4. **Clustering themes:** As suggested by Waring & Wainwright (2008), key descriptors or themes were established from the literature review and set as a guide for the interviews. Themes were identified and coded hierarchically and then organised by topic. Ongoing analysis led to the development of higher-level codes and more detailed codes.
5. **Template development and refinement:** The themes identified in the previous step formed the basis of a template that was refined over time. Template analysis is an iterative process that enables the template to be changed to accommodate changes in the literature, research scope and develop a hierarchy of themes (Waring & Wainwright 2008).
6. **Interpretation of interviews:** The themes within and across transcripts provide insights into key topics that could support or explain themes from other data sources, such as surveys and site analysis.
7. **Validation:** As a final review, member checking was conducted by summarising the data collected from the informant with the inclusion of some notes on how their perspectives differed from other interviewees' perspectives. This information was presented to the informant for feedback or discussion. An independent check by the researcher's supervisors was sought for additional rigour.

A template was created to guide the data analysis and new categories added as they emerged. Categories were collated into themes (Waring & Wainwright 2008). The topic areas that informed the first levels of data analysis are listed below.

Table 5.2 Template analysis of interviews: Key themes/categories and codes

Coding	Key theme
1	Location & amenities
2	Ergonomic support & training
3	Office layout & features
4	Indoor environmental quality
5	Measurement of existing environment and employee responses
6	Organisation values/focus
7	Flexibility and mobility
8	Health programs & gym
9	Flexibility/hours
10	Additional themes in post-move interviews

Quantitative methods: before- and after-move occupant surveys

The principal objective of these surveys was to understand in detail the occupant's perceived health and their response to designed environments before and after the move between sites. Surveys collected data on participants' health, design elements and work-related factors. Perceived health was assessed using the SF-12, a standardised, robust health assessment tool with established norms for the Australian population. Respondents were also asked to rate the impact on and importance to their perceived health of specific design elements and other factors. Additional questions focused on the physical environment, organisational policies, and other work-related factors.

Aristizabal et al. (2019) discussed the benefits of surveys to measure perceived health, including ease of administration and low resource requirements. The authors also noted the disadvantages of surveys, including questions being interpreted differently by different respondents and varied motivations for survey completion. In this study, the potential limitations of surveys for measuring health were addressed by including a valid and reliable instrument (SF-12), deriving survey questions from existing research, and testing the survey instrument. The survey provided an opportunity to explore patterns and compare groups.

Design of the survey

The survey consists of 66 questions in four parts (Appendix A Before-move survey Appendix B After-move survey. The survey commenced with specific questions about elements known to impact occupant health in and beyond the workplace.. The next section asked participants to rank various workplace elements for their importance to their health. This was followed by the SF-12 questions, and the survey ended with demographics questions. Keeping the length of the survey manageable to maximise completion rates was also a consideration. The same survey questions were used both before- and after-move.

Two additional questions were added to the after-move survey The first recorded which before-move site the respondent had come from, and the second addressed the ABW environment that only existed in the after-move environment. The purpose of using essentially the same survey at both stages was to understand the change and magnitude of change in responses between the different workplace environments. The survey questions and the rationale for including them will now be presented.

Survey format and questions

The survey was structured according to the literature review findings and the BOSSA survey tool (Building Occupant Survey System Australia (BOSSA) 2018a). A five-point Rating Scale was developed for 25 items focused on respondents' perceptions of impact. Responses were along the continuum from 'significant negative' to significant positive' impact. A five-point rating scale for impact is consistent with the format of similar measures (e.g. (Maass 2016)). The scores were treated as continuous variables to generate a score that was easy for readers to understand. For example, 'significant negative impact' scored 1, and 'significant positive impact' scored 5. The middle option of 'neutral-no impact' scored 3, indicating results above 3 are positive and those below 3 are negative. Many POE studies use similar scales, including the industry-standard BOSSA, CBE and BUS. Individual studies, such as the before- and after-office move studies completed by Agha-Hossein et al. (2013) and Vischer (2008), include similar surveys.

The surveys (Appendix A Before-move survey Appendix B After-move survey) six domains and the number of questions in that domain were:

1. Individual work point, including questions about the desk, chair, length of time sitting per day and extent of ergonomic training (nine questions).
2. Office landscape or layout, including the type of office layout, availability of different settings, and opportunities to stand and use stairs (17 questions).
3. IEQ, including thermal comfort, air quality, daylight and acoustics, allowing for comparison with previous BOSSA results (eight questions). Rating scales used the present study were adapted from industry-recognised rating tools such as BOSSA (Candido et al. 2016), WELL (International WELL Building Institute 2018) and Fitwel (Centre for Active Design 2010b).
4. Workplace-related factors known to impact health outcomes such as flexibility of work location and hours are included to encompass a salutogenic perspective (13 questions)
5. SF-12 survey questions were included to capture health status (Le Grande et al. 2019; Tucker, Adams & Wilson 2010; van den Berg et al. 2008) (12 questions). Past studies of office workers have measured activities such as sitting time or steps taken which may not indicate a true reflection of overall health status.

6. Demographic and general questions including gender, age, work role and hours worked (four questions).

Consent to participation was requested on the opening page of the survey. If the participant did not agree to participate, they were unable to complete the survey.

Survey Part One

The first part of the survey focused on the physical elements of the office workplace. The rationale and references for the inclusion of each element are listed in Table 5.3. The impact of each element is investigated. The noun ‘impact’ is used as it is defined as ‘a powerful effect that something, especially something new, has on a situation or person’ (Cambridge University Press 2021b). This study aims to understand which elements have the greatest effect on health, positive or negative; hence the noun ‘impact’ has been chosen. Any variations in reported impact between each of the workplaces and associated elements were overlaid with site information. This convergence of data allowed drawing conclusions on the elements of most significant impact on occupants’ health.

The survey questions and rationale are summarised in the following table (see over).

Table 5.3 Part One: Survey questions and rationale- Before and after move

(Refer Appendix A Before-move survey page 214, Appendix B After-move survey page 235)

Factor	Survey question	Response	Measurement	Rationale
Individual work area	In general, how satisfied are you with your work area's furnishings such as desk and chair?	Five-point scale, 'very unsatisfied' to 'very satisfied'	Continuous 1-5	Research indicates a positive correlation between satisfaction with the interior space and perceived well-being (Agha-Hossein et al. 2013; Kim et al. 2016; Robertson, Huang & Larson 2016). Satisfaction with before and after-move offices can also be compared.
Standing time	While at your desk, how long do you stand at your desk in total during a typical day?	Minutes or hours	Continuous	Having the opportunity to stand throughout the day is shown to mitigate the impact of long periods of sitting and reduce discomfort (Alkhajah et al. 2012; Karakolis & Callaghan 2014; Neuhaus, Healy, et al. 2014). Responses can also be compared with other studies to understand how the case study cohort compares.
Standing time	Do you stand up for any other tasks during the day e.g., meetings?	• Meetings • Standing required for work role • No standing required • Other, please indicate	Nominal	Understanding if participants are able to stand at standing height settings throughout the workday- known to positively impact health (Buckley et al. 2015; Karakolis & Callaghan 2014). Intermittent standing is known to reduce the negative impact of too much sitting (Thorp et al. 2014) Response options were based on current practice in contemporary offices; e.g. some meeting spaces with bench height standing tables.

Factor	Survey question	Response	Measurement	Rationale
Desk	Rate the impact of your desk or workstation on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses. Desk type was recorded from interviews and observations. Height-adjustable desks can reduce sitting time and musculoskeletal complaints (Alkhajah et al. 2012; Neuhaus, Eakin, et al. 2014). Responses also indicate the level of understanding of the health benefits of standing or change of posture throughout the day.
Sitting time	In a typical day, how long do you spend sitting in the chair provided?	Minutes or Hours	Continuous	Studies suggest the duration of sitting can have measurable negative impacts on health and increase the likelihood of preventable diseases (Boyce et al. 2008; Hua & Yang 2013; Owen et al. 2010).
Ergonomic chairs	Rate the impact of your chair on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Quality and type of office chair can impact level of support and comfort (Groenesteijn et al. 2012; van Niekerk, Louw & Hiller 2012). Rating allows for comparison between before and after-move responses
Training & messaging	Have you had any training or instruction on how or why to use your desk or chair properly?	• No • Yes • Not sure	Nominal	Research indicates that the amount of training can impact correct use of seating and ergonomic health (Amick et al. 2012; Robertson et al. 2008)
Training type	What sort of training or instruction?	• Written • Online • Individual training session	Nominal	Studies indicate that the type and training and messaging can impact ergonomic outcomes (Alkhajah et al. 2012; Amick et al. 2012; Gilson et al. 2016; Healy et al. 2013)

Factor	Survey question	Response	Measurement	Rationale
		• Group training session • Other		Listed options are based on described practices from the literature review.
Ongoing training	Have you had any ongoing follow-up training or information on using your desk or chair?	• Yes-in person • Yes- via digital methods • No	Nominal	Research indicates that the amount of training can impact the correct use of seating and ergonomic health (Amick et al. 2012). The amount of ongoing training and support for ergonomic best practice also provides insight into the case study organisation and how health training or promotion is valued. Listed options allow for an affirmative response with two variations and a negative response.
Layout	In general, how satisfied were you with your work area's layout are?	Five-point scale, 'very unsatisfied' to 'very satisfied'	Continuous 1-5	Research indicates a positive correlation between satisfaction with the interior space and perceived well-being (Agha-Hossein et al. 2013; Candido et al. 2018; Kim et al. 2016).
Open offices & layouts	Describe your work area.	• Private office • Shared private office • Open-plan with high partitions, 1.5 m • Open-plan with lower partitions less than 1.5m • Open-plan without partitions	Nominal	Listed options are based on contemporary workplace furniture, layouts, and settings adapted from the BOSSA survey (Building Occupant Survey System Australia (BOSSA) 2018b). The five options will cover most standard settings with an additional option to describe another setting not listed. Comparisons between the before and after-move responses floorplan layouts can be made.

Factor	Survey question	Response	Measurement	Rationale
		• Other- please indicate		
Open offices & layouts	Rate the impact of this layout on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Research available indicates open offices or different layouts can impact occupant health (Bergström, Miller & Horneij 2015; Danielsson et al. 2014; Herbig, Schneider & Nowak 2016; Pejtersen et al. 2011)
Open Layout	If you have moved to an open-plan workplace, have you noticed any health impacts?	• Have always been in open-plan • Fewer sick days • No change between workplaces • More sick days off	Nominal	Research indicates that different layouts or densities can impact occupant health (Engelen et al. 2018; Roulet et al. 2006) . The listed options allow for a negative, neutral and positive response.
Open Layout	Approximately how many more sick days do you have off since moving to open-plan?	Open question	Continuous	Absenteeism can be compared between before and after-move sites. A move to open-plan increased sick leave rates (Danielsson & Bodin 2008). Absenteeism data available from case study organisation allows for comparison with survey results. Open question, to minimise potential bias.
Distance to amenities	Do you have to walk far to kitchen & bathroom facilities?	• No, close to desk • Yes, same floor but more than 3 mins walk • Yes, different floor	Nominal	Research indicates different layouts may impact occupant health (Hua & Yang 2013; Rassia 2014) Listed options give an indication of office layout and how much walking is required for essential activities based on Hua & Yang (2013) study

Factor	Survey question	Response	Measurement	Rationale
Distance to amenities	Rate the impact of the distance to kitchen and bathroom facilities on your health.	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses
ABW environments	Rate the impact of this ABW office on your health?* *After-move survey question only	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Research available indicates different layouts such as ABW can impact occupant health (Engelen et al. 2018; Kim et al. 2016). Increased physical activity moving between settings is a recognised health benefit (Candido et al. 2020; Foley et al. 2016).
Variety of settings	Do you choose settings or spaces where you can stand instead of spaces with standard desk height or seating?	• Yes, always • Yes, sometimes • No, I choose not to use a standing setting • No, I am not able to choose	Nominal	Studies examining intermittent standing suggests a reduction in fatigue levels (Thorp et al. 2014) and health improvements (Owen et al. 2010). Listed options provide evidence of how much standing is available and if occupants choose to stand throughout the day. Listed options offer affirmative and negative options with variations.
Variety of settings	When you choose different places to work or meet, do you consider your health?	• Yes, always • Yes, sometimes • No, I haven't really thought about it • No, my health is not a priority at work	Nominal	Research indicates that different layouts or models can impact occupant health (Kim et al. 2016). Question raised to understand if occupants are aware of health impacts of different settings or choices within the office layout. The importance of health to individuals is also queried. Listed options offer affirmative and negative options with variations.

Factor	Survey question	Response	Measurement	Rationale
Variety of settings	Rate the effect on your health of being able to choose where you work.	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.
Access to stairs	Does your office have easily accessible internal staircases?	• Yes, stairs part of office design • Yes, fire stairs are open to use • No, security or other limitations stop access • Not applicable, single floor-we don't have stairs	Nominal	Research indicates that different layouts and elements can impact occupant health (Engelen, Dhillon, et al. 2016; Jancey et al. 2016; Meyer et al. 2010; Rassia 2014). Fitwel notes that the design of stairwells can impact usages, so need to understand stair types (Centre for Active Design 2010b). Listed options can be compared with actual site conditions to understand if occupants are aware of stair types and choices. Offers affirmative and negative options with variations.
Access to stairs	In a typical day, how many times do you use the stairs instead of lifts between work floors?	Open	Continuous	Use of stairs throughout the working day is recognised to positively impact health (Jancey et al. 2016; Meyer et al. 2010; Pronk 2015). Open question that is not leading to allow individual responses.
Access to stairs	Rate the impact of access to internal stairs on your health.	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.
Assigned or Unassigned desking	Which of these best describe your current desking arrangement?	• Fixed location, I have my own desk and sit	Nominal	Candido et al. (2018) and Kim et al. (2016) suggest that ABW or unassigned environments may improve satisfaction and perceived well-being.

Factor	Survey question	Response	Measurement	Rationale
		at same desk every day • No fixed location, I move to a different desk every day • No fixed location, I love to use a different desk some days		Listed options are based on variations in current practice in contemporary ABW environments. Amount of movement between desks reflects organisational management and practice of ABW.
Assigned or Unassigned desking	What type of desking arrangement do you prefer?	• Have own desk • All desks shared • Other, please indicate	Nominal	Rating allows for comparison between before and after-move responses. Listed options to understand preferences relative to actual environment and option for other arrangements not listed.
Assigned or Unassigned desking	Rate the impact of desking arrangement on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.
IEQ	In general, how satisfied are you with your work area's indoor environmental quality?	Five-point scale, 'very unsatisfied' to 'very satisfied'	Continuous 1-5	Provides context or background to survey responses. Research indicates a positive correlation between satisfaction with the interior space and perceived well-being (Agha-Hossein et al. 2013; Candido et al. 2018; Kim et al. 2016).
IEQ	In general, how does the overall indoor environment quality impact your health?	Five-point scale, 'significant negative impact' to 'significant positive impact'	Continuous 1-5	Research available to indicate various elements of IEQ can impact occupant health (Bluyssen et al. 2016; Hedge et al. 1989; Lamb & Kwok 2016).

Factor	Survey question	Response	Measurement	Rationale
				Rating allows for comparison between before and after-move responses.
Indoor Air Quality (IAQ)	In a typical week, how does the air quality in your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Research available to indicate various elements of IAQ can impact occupant health (Nriagu 2011; Singh et al. 2010; World Green Building Council 2014)
Thermal Comfort-Winter	In a typical week last winter how did the temperature of your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Associated with levels of satisfaction which is often linked to levels of perceived health (Mujan et al. 2019) and productivity (Lan, Wargocki & Lian 2011; Vimalanathan & Babu 2014).
Thermal Comfort-Summer	In a typical week last summer, how did the temperature of your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Associated with levels of satisfaction which is often linked to levels of perceived health (Mujan et al. 2019)
Daylighting	In a typical week, how does access to daylight in your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Access to daylight is known to impact health and sleep patterns (Begemann, van den Beld & Tenner 1997; Boubekri et al. 2014; Das 2015; Mills, Tomkins & Schlangen 2007) and impacts absenteeism (Mujan et al. 2019).
Office lighting	In a typical week, how does the quality of the office lighting in your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses. Meister (2019) study indicates that lighting is highly important to office workers and their health.

Factor	Survey question	Response	Measurement	Rationale
Acoustics and noise	In a typical week, how does the noise or acoustics in your normal work area impact your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Provides context or background to survey responses. Enables comparison between before- and after-move responses. Research suggests that noise can impact health (Mujan et al. 2019; Perrin Jegen & Chevret 2016).

Survey Part Two

Elements beyond the physical workplace have been included to understand workplace health at a broader holistic level. These include flexible hours, choice of work location, and commuting times. The literature review identified that organisational factors that complement designed workplace elements can further improve health outcomes. Despite research suggesting that flexibility has both negative and positive health outcomes, it has been included in this study to better understand this specific workplace policy. The included workplace elements are based on those identified as important, prevalent or significant from the literature review.

Table 5.4: Part Two: Survey questions and rationale-other workplace factors- Before and after move

Factor	Question	Response	Measurement	Rationale/Note
Flexibility of work hours	Does [organisation] allow for flexible hours?	• Yes, company-wide • Yes, within my department or team • No, set working hours • Informal arrangement	Nominal	Flexibility is known to positively and negatively impact work-life balance and other health-related outcomes (Hayman 2010). Before- and after-move case studies by Agha-Hossein et al. (2013); (Nijp et al. 2016) are good examples. Listed options offer affirmative and negative options with variations.
Flexibility of work hours	Do you have any comments about flexible working hours?	Open question		Open question, to discover broader responses that may be unique to this organisation.
Flexibility of work hours	Rate the impact of flexible or set hours on your health?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses
Flexibility of work location	Can you choose the geographic location of where you work? In office? At home? Co-working space?	• Yes, full choice • Yes, some flexibility of location • No choice, need to be in office during working hours	Nominal	Flexibility impacts work-life balance and reduces commuting (Hilbrecht, Smale & Mock 2014; Nijp et al. 2016). Listed options offer affirmative and negative options with variations.
Flexibility of work location	Rate the impact on your health of your ability to choose work location?	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.

Factor	Question	Response	Measurement	Rationale/Note
Commuting time	How long is your typical commute to work ONE way? Journey time from home to work?	Minutes	Continuous 1-180	Commute time impacts time to engage in healthy activities such as fitness activities or walking/cycling to work- opportunities for physical activity throughout the day (Hilbrecht, Smale & Mock 2014; Oja et al. 2010) Minutes was recorded in line with other commuting studies (above). Actual distance may distort results.
Commuting time	Rate the impact of your commuting time on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.
End of trip facilities (ETF) in office building	Do you use ETF in order to walk/run/bike to work?	• Yes- regularly • Yes- occasionally • No- I don't wish to bike/run • No-I can't bike/run/walk due to no adequate facilities • No-I bike/run/walk but choose not to use facilities	Nominal	EFT impacts time and access to healthy activities such as fitness activities or walking/cycling to work- opportunities for physical activity throughout the day (Page & Nilsson 2017). Listed options offer affirmative and negative options with variations to cover a range of options providing insight into the importance of ETF for active commuting for those that choose it.
EFT	Rate the impact of your ETF on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.

Factor	Question	Response	Measurement	Rationale/Note
On-site gym or access to active spaces	Indicate your access to gym facilities	• Yes-on site and free • Yes-on site and need to pay • Yes- close by and free • Yes- close by and need to pay • No access	Nominal	Gym access impacts time to access healthy activities such as fitness activities or walking/cycling to work- opportunities for movement throughout the day. Meister (2019) suggests low priority for occupants. Listed options offer affirmative and negative options with variations providing insight into whether there are barriers to gym use such as cost and location.
Access to gym	Rate the impact of access to gym facilities on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.
Health incentives/programs	Does [organisation] offer any incentives to being healthier? Gym membership, health seminars?	No. Yes- please indicate	Nominal	Indication of organisational commitment to employee health and well-being (Goetzel & Ozmlnkowski 2008; Ni Mhurchu, Aston & Jebb 2010). Meister (2019) suggests low priority for occupants. Listed options offer affirmative and negative options with open comments to allow for specific details to be collected and measure awareness of any programs.
Health incentives/programs	Rate the effect of your access to health promotions on your health	Five-point scale, significant negative impact to significant positive impact	Continuous 1-5	Rating allows for comparison between before and after-move responses.

Survey Part Three

As for the previous survey sections, elements included in this section were derived from the literature review and the relevant studies listed in the previous tables. In addition, factors included in WELL, such as air, light, movement and thermal comfort, are known to impact occupant health (International WELL Building Institute 2018). The Fitwel system identifies specific building attributes such as stairwells, workspaces, shared spaces and location (Centre for Active Design 2010b), and these are also adopted. Further supporting material is the BOSSA POE survey tool, which examines several indoor elements such as spatial comfort, air quality, thermal comfort in winter and summer, and individual work point (Building Occupant Survey System Australia (BOSSA) 2018b).

For the measure of importance (15 items), a seven-point Semantic Differential scale was adopted, from 'highly important' to 'not very important', to provide a finer level of detail for this construct (Verhagen 2015). This format is also consistent with the industry-standard BOSSA. The concept drawn upon for this part of the survey relates to the *value* participants place on particular elements within the workplace. The noun 'importance' is defined as 'the quality of being important', and the adjective 'important' is defined as 'of great value, meaning or effect' (Cambridge University Press 2021a). Therefore, the noun 'importance' has been selected to understand the value that individuals place on the nominated element within the workplace. While a factor may 'impact' a respondent's health (as in 'to have an influence on' their health), the 'importance' of an element to their health involves the respondent's evaluation of the element's value. The data collected from this survey were analysed to determine the factors that occupants viewed as being of greater importance for their perceived health. This information could be useful in future research projects or salutogenic recommendations when prioritising the inclusion of one element or factor over another. As an example, the importance of flexible hours to a working woman with young children is likely to be different from the importance of flexible hours to a working man without young children. The data also permitted triangulation of responses from Parts 2 and 3 of the survey. The elements in Part 3 have been listed in the same order as the previous section (Part 2) of the survey.

The elements for rating in this question are choice of work location, choice of flexible hours, commuting time, end of trip facilities, access to gym, employer health programs, type of desk, type of chair, proximity to other workers, openness of layout, variety of settings, ability to use stairs, ability to choose different desks, indoor air quality, thermal comfort, access to daylight, adequate lighting and noise levels.

Survey Part Four

The SF-12 survey is a standardised health status measure that provides the perceived health status of participants in both the before- and after-move work environments. The SF-

12 has been selected because it has good reliability (Sanderson & Andrews (2002), can be completed in two minutes (Tucker, Adams & Wilson 2010; Ware, Kosinski & Keller 1996) and is easy to understand (Le Grande et al. 2019). This SF-12 short health survey has been used in more than 130 studies in Australia (Tucker, Adams & Wilson 2010) and in other studies of office workers abroad (Wynne-Jones et al. 2009). Approval to use the SF-12 survey was granted by Optum on February 2018 and a non-commercial licence agreement was made (#QMO4467).

The SF-12 rates general health status, fitness levels, and activity limitations due to health status including limitations in climbing several flights of stairs or undertaking moderate activities such as playing golf. The SF-12 also collects data on the extent to which pain interferes with completing work and home-based activities. The final part of the SF-12 survey covers questions associated with mental health, assessing levels of feeling calm and peaceful and feeling down-hearted and low. Responses to the SF-12 generate two health scores, a physical composite score (PCS) and a mental composite score (MCS). Weighted-PCS scores can range from 4 to 73, and weighted-MCS can range from 8 to 74, where a higher score indicates better health.

Survey Part Five

The survey concludes with four questions to record occupants' demographics, including their job role. Three age group categories were used: under-30, 31-50 years and over-50 years. These are the same age categories used in BOSSA (Building Occupant Survey System Australia (BOSSA) 2018b). Gender included 'male', 'female', 'other' and 'prefer not to say'. Five options for job descriptions were provided: 'administrative', 'technical support role', 'professional/mid-level', 'managerial/senior executive' and 'other'. These categories were also adapted from BOSSA. The final question related to working hours per week was adapted from BOSSA. Rasheed, Khoshbakht & Baird (2021) concluded there were significant difference in reported productivity, comfort and health depending on time spent in the office. These responses allowed for later analysis to identify links between perceived individual health and participants' gender, roles, age and typical weekly hours spent in the workplace.

Survey testing and validation

Before issuing the final survey to the organisation, the survey was piloted, and detailed feedback was obtained from the test respondents. A variety of individuals with differing backgrounds, roles, expertise and ages provided feedback at each of the three stages of pilot testing; the survey was then further refined. The questionnaires used in this research were designed using SurveyGizmo (SurveyGizmo 2018). The NABERS guidelines for industry professionals conducting occupant surveys (NSW Office of Environment and

Heritage 2015) were followed while designing the questionnaires. The stages of the piloting of the survey were:

Stage One: The basic framework and layout of the proposed survey was completed based on feedback from supervisors, survey designers and eight industry professionals. All survey items were reviewed for face validity, and changes made to terminology to address the case study context.

Stage Two: Using the SurveyGizmo platform (the name of the platform has since been changed to Alchemer, Louisville CO), the questionnaire was emailed via a digital link to six office workers believed to be similar to the potential participants; this was to check whether the terminology and framing were clear. The survey was further refined; minor changes were made to ensure that participants would understand key terminology such as ‘desk’ (not to be confused with ‘workstation’) and ‘ergonomic chair’ (not to be confused with ‘task chair’).

Stage Three: Six individuals from the case study organisation completed the survey for approval and to provide any further suggested changes. The term ‘activity-based working environment’ was included in the after-move survey, and it was thought that some participants might not have been familiar with this term. However, the case study organisation indicated that this term had been central to many communications about the future workplace. After the pilot testing was complete, the survey was ready for research participants.

Distribution of survey and data collection

The study organisation’s contact person was advised how to communicate information about the survey and how to encourage people to participate. The contact person was also given a presentation for use with potential participants. It was jointly decided between the researcher and contact person that communication would go via the contact person for several reasons. Firstly, for ease of delivery and acceptance as the survey email link would be sent via an internal company email address which would be recognised and avoid any firewall issues. Secondly, all previous surveys and workplace communications had been issued via the contact person so it was expected and accepted by employees. Past experience from the organisation indicated higher response rates to surveys where achieved when issued via a known company employee. Organisation staff emailed potential participants a link to a website from which participants could access the questionnaire for online completion. The link was active for approximately two weeks.

Study sample

Further to the criteria established previously in this chapter, an organisation that employs a minimum of 700 people and requests all employees to participate at the before and after-

move workplace sites was required. Participants were required to be aged over 18 years and employed full- or part-time by the nominated organisation. A balance of genders was sought for the survey distribution, as was a broad range of ages.

This study aimed to explore changes in perceived health status and other factors before and after the office relocation. The key outcome variables, composite SF-12 physical and mental health scores, have been widely studied, with a difference of two points in mean scores considered statistically significant (Bakker & Wicherts 2014; De Cieri 2019). This was therefore chosen as the basis of the sample calculation. The sample size for the before- and after-move components was determined using Gpower 3.1.0, assuming a medium effect size of 0.4 (a difference of two points in the mean composite scores of the SF-12, with a standard deviation of 5) and a significance level of 0.05 and power of 0.95 for two-tailed, non-parametric independent samples test. This indicated that a sample size of 172 was needed for each of the before- and after-move data collection rounds. This was well within the estimated sample for the population.

Analysis of the before- and after-move surveys

The statistical analysis aimed to draw comparisons between the sites and evaluate any differences in individual health between the cohorts. Statistical software SPSS 25 (IBM Corp) was used for this analysis (Field 2017). The statistical analysis was conducted on data collected during four stages of this study:

1. Before-move data were collected from the two before-move sites. The occupants of one before-move site (Site A) are referred to as ‘Cohort A’, and the occupants of the other before-move site (Site B) are referred to as ‘Cohort B’. Cohorts A and B were compared with each other in the analysis. Descriptive statistics were calculated for each variable to generate the mean and standard deviation for each site. Descriptive statistics were also calculated for data from both sites combined.
2. In the case of the before-move sites, available BOSSA data were reviewed for comparison and benchmarking only.
3. The SF-12 part of the survey was processed using the algorithms provided by Optium. SF-12 PSC and MCS were also calculated and compared with community norms scores (De Cieri 2019) to see how the research participants compared to the wider community.
4. After-move data (from Site C) were compared with before-move data (Sites A and B combined).
5. The final analysis was of the data from the questionnaires of the combined pre-move cohorts A and B at the after-move site (Site C) as well as their SF-12 health status scores.

Statistical analysis at both before- and after-move stages included the following non-parametric and parametric tests as suggested by Bakker & Wicherts (2014) and Field (2017):

- Descriptive statistics (frequency, mean and standard deviation) were calculated for variables.
- Differences between the means for continuous variables were calculated using Independent samples t-tests (Carver (2010). Key elements in the office environment and workplace polices identified in the literature review were tested.
- Scores from questions using the 5-point and 7-point scales were treated as continuous data
- Independent samples Mann-Whitney U Test & Wilcoxon test (WMW) were used for non-parametric data. The WMW test was most suitable for this study as it handles continuous variables, tests the difference in mean ranks between two samples, and requires few assumptions (Fay & Malinovsky (2018)
- An exploratory graphical analysis of SF-12 scores from the after-move survey data was undertaken. Elements identified as significantly different or of importance were included in this analysis. As described by Friendly (2002), graphical analysis allows the visual exploration of patterns among variables.

A concise and relevant process for quantitative analysis set out by Creswell (2011) has been adopted:

1. **Data Preparation:** The raw data from the questionnaire were imported into an IBM SPSS 25© file and cleaned in preparation for data analysis. Outlier data was removed.
2. **Exploration:** Descriptive statistical tests completed and reviewed to identify any early trends.
3. **Analysis:** The statistical tests listed above were used to determine relationships between variables, such as the relationship between variables measuring workplace elements and office workers' perceived health. The three datasets were compared to detect differences in the effects of the independent variables on the dependent variables.
4. **Representation:** Presentation of the data was designed to be readable and usable in tables and graphic formats. Key findings are provided in statements supported by tabulated summaries of data.
5. **Interpretation:** Results of the qualitative analysis of the interview and site analysis data were integrated with the quantitative analyses. and considered in the context of the relevant literature (Literature Review, p. 25).
6. **Verification:** Results were re-checked and tested at this final stage to ensure accuracy of findings.

Integration of qualitative and quantitative data

As indicated in point 3 above, merging the analyses of the qualitative and quantitative data was done to identify connections between the various data sources (Table 5.5). For example, survey findings were displayed side by side with the emerging themes from the interviews to articulate any convergent or divergent responses. Site data such as photos and site observations provided another source of information to further contextualise quantitative responses. As suggested by Creswell (2011), a matrix format was developed using the broad emerging themes noting all supporting and incongruent data relevant to the research questions. This visual process of merging analyses provided valuable insights that responded to the study aims.

Table 5.5 Data sources

Data Source	Before-move sites (Sites A and B)	After-move site (Site C)
Interviews of KIs	✓	✓
Surveys	✓	✓
Site analysis data of Sites A, B & C	✓	✓
BOSSA data Sites A and B	✓	*
Observations: site photos & notes from visits	✓	✓
Absenteeism data (from organisation)	✓	✓

* BOSSA data for after-move site was not available due to organisational constraints and change in priorities at the time.

Ethics approval and participant consent

The research was approved by the UTS University's Human Research ethics committee on 8 June 2018 (ID number ETH18-2529). The approval letter is provided in Appendix E Ethics Approval. Copies of the consent form were approved by the ethics committee and are included in the Appendix D Information and Consent Form for Interviews. Completed consent forms were securely stored as detailed below. Participant recruitment was through existing professional networks; however, no pre-existing personal relationships with specific employees or participants were leveraged. No respondents were identified as being from a vulnerable population. Participation in this research did not infringe any rights, privacy or the professional reputation of those involved. All correspondence and activity were conducted professionally. Participants were told the purpose of the study and that participation was voluntary. They were asked to sign a consent form before any data was collected. Participants' involvement did not put them at risk of harm beyond that experienced in everyday activities, although participation may have created some inconvenience. Only those willing and able to complete a questionnaire or participate in an

interview were able to participate. The ethical issues specifically associated with this research and how they were addressed are detailed below:

Survey implementation: Before issuing the survey to potential respondents, a link to the survey was issued to key stakeholders and relevant management for review and approval. Following this, the survey was issued via a digital link in an email sent from within the organisation. All survey work included all necessary university ethics approvals obtained before implementation. To protect participant privacy, the researcher did not access email addresses or have direct contact with the survey participants. To limit inconvenience, the survey could be completed at a time suitable to the employee over two weeks. The survey had some sensitive questions about health, and ethical implications of this were managed by ensuring potential participants could withdraw at any time, as participation was voluntary. Further, all respondents were anonymous.

Interviews: Participants were invited to participate by the contact within the organisation to limit potentially uncomfortable feelings or pressure to participate by the researcher. The interview questions were approved by management within the subject organisation and issued to participants before the interview along with the consent forms. Before each interview, consent forms were presented, discussed and signed. Interviews were conducted within the workplace in environments known to the participants to avoid unnecessary travel or the need to adjust to an unknown environment. During the interviews, the researcher showed respect and sensitivity to all participants.

Organisation information and data: The participating organisation was requested to provide limited organisational information that was aggregated and anonymous. Confidential or sensitive personal or financial information about participants was not sought. The organisation will remain anonymous unless they formally request to be identified.

Specific site information: Floorplans of the subject sites appear in this thesis creating a risk that the building may be identifiable. However, the company and level of the building are not included so specific company information is less identifiable. Any further publishing of site information will only be done with the full written consent of the case study organisation.

Privacy and data storage: This research was conducted in conformity with all Australian Privacy Principles. Names were not requested for the individual survey participants, and the address of the case study organisation will not be published. Digital audio files of interviews were stored securely and no video data were collected. Interviewees have been deidentified in the audio files, so no one person will be recognisable. Parts of interviews

and comments may be published, however, the names of interviewees will not be published.

Data management and storage: In consultation with UTS Library staff, a data management plan was developed. All working data files, including interview audio and SPSS statistical files, were saved in the UTS-recommended CloudStor and transferred to the UTS Stash system for a minimum of five years following the publication of this thesis. Active emails and documents are part of the UTS system, which is password protected. The computer used for the thesis work was password protected. Audio files and transcripts were saved separately and data coded to remove any names or identifiers.

Reflective statement

My education and training in design and connections to organisations through my employment gave me a unique understanding of the insights that designers and consultants were seeking. I was aware that industry conversations were taking place on the need to address health in the workplace, but outcomes based on evidence appeared to be lacking. In the early stages of this research, I discussed my research ideas with industry colleagues and business connections to determine the research outcomes that would be of most practical value and most likely, from their perspectives, to improve health outcomes for office workers.

The participant organisation became known to me by discussions with industry contacts, and introductions to relevant decision-makers were sought. I engaged with the organisation to determine whether the organisation was willing to participate in this research. During this research, as part of my usual employment, I worked with other organisations, designers, and project consultants, which helped me understand workplace needs, including office furniture requirements. Therefore, I have a pragmatic and practical view of workplace design, implementation and operations.

Summary

The proposed mixed-methods approach using a convergent parallel design as part of a case study designed to generate a set of results that respond to the three research questions central to this thesis. The survey data discovered the elements that were of greatest importance to, and had the greatest impact on, office workers' perceived health. Furthermore, the interviews and site analysis provided context for analysing the occupant response or participants' perceived health in three different workplace environments. The analyses of these complementary qualitative and quantitative data sources were merged to generate a holistic perspective of the office workplace and associated health impacts. The before- and after-move case study design allowed for an in-depth investigation of specific

sites with later comparison to identify how changes in office environments impacted occupants' perceived health status.

Chapter 6 Results 1 – Site analysis and interviews

Introduction

This and the following chapter present the results of the study. In this chapter, the results of the interviews and site analysis will be presented. Chapter 7 will outline the results from the quantitative surveys conducted before and after the office relocation. Chapter 7 also presents the findings from the SF-12 survey to show how physical and mental health was affected by changes in the physical office environment.

A case study site was chosen at which data were collected before and after an office relocation. Before-move data were collected from two sites (Site A and Site B) and after-move data was collected from Site C, which amalgamated workers from Sites A and B. This chapter presents an in-depth description of the two before-move office environments (Sites A and B) and the one after-move workplace (Site C). It also presents the findings from the interviews with managers and leaders involved in the workplace design, implementation and operations. Comparisons are made between the two sites before moving and between each of the sites after the move. Following these site descriptions, key themes identified from the interviews are presented for each stage (before- and after-move).

The case study organisation

The study organisation is referred to in this thesis as ‘Locomotion Ltd’. It is a large transport and logistics company located in Queensland, Australia. In 2013, the company initiated a strategy to consolidate their Brisbane offices from nine to two locations. The two offices were part of this study and referred to as before-move Site A and Site B. A further consolidation occurred in 2018, and the two offices merged into a single workplace known as after-move Site C. In addition to these office locations, the organisation had employees in regional industrial field sites that are not within this research scope.

The roles and functions of these offices include IT, logistics management, real estate and asset management, HR, strategic infrastructure planning and management, financial management and WHS management. Locomotion Ltd.’s business practices would appear to be reasonably representative of organisations with a strong culture centred on workers’ safety and risk minimisation of industrial operations. The organisation was experiencing reduced demand for its products and services due to reduced coal mining in its geographic area. The table below summarises the key features of the office workplaces, Sites A, B and C.

Table 6.1: Summary of attributes of case study sites A, B and C

Feature	Before-move		After-move
	Site A	Site B	Site C
Occupants (n)	502	720	790
Floor area (m^2)	8,382	10,702	11,686
Interviews (n)	4	5	4
Survey responses (n)	160	147	208
BOSSA reports available	Yes	Yes	No
Floor plans	Yes	Yes	Yes
Site visits (n)	5	5	4
Study completed	Jun-18	Jun-18	May-19

The organisation moved into the new site in July 2018. After-move data were collected 10 months later, in May and June 2019. All staff moved from Site A (Cohort A) and Site B (Cohort B) to Site C on the CBD fringe.

Key informants' characteristics (KI)

Table 6.2 presents the relevant characteristics of the KIs. KIs were employees of Locomotion Ltd and occupied a study office site, excluding KI 1019, an external consultant. Two senior executives (KI 2 and KI 5) were involved in the design of Site B and Site C. The remaining participants were involved in managing the before-move workplaces and the design and implementation of Site C.

Table 6.2 Key informant (KI) characteristics

Key informant	Role in Locomotion Ltd	Level of influence	Site of Interview
KI118	Facility management for Site B	Project Manager - mid level	B
KI218 &KI219	Real estate planning	Senior Executive - leadership	Sites A & C
KI318 KI319	Move coordination for Site C	Project Coordinator - junior level	Sites B & C
KI418	Project management of Site C	Project Manager - mid level	A
KI518 &KI519	Development management	Senior Executive - leadership	Sites B & C
KI618	Business process	Project Manager - mid level	A
KI718	Change management	Project Manager - mid level	B
KI818	Real estate management	Project Manager - mid level	B
KI918	Facility management	Project Manager - mid level	A
KI1019	Lead designer, Site C only	External Project Manager	Site C

As the interviewees' roles varied, the semi-structured format of the interviews allowed for the most relevant questions to be presented. The following table summarises the key interview themes and which informant was asked which questions.

Table 6.3 Semi-structured interview questions by key informant

Questions	Pre-move									Post-move			
Key informants	1	2	3	4	5	6	7	8	9	2	3	5	10
Site	B	A	B	A	B	A	B	B	A	C	C	C	C
Opening general questions		X	X	X	X	X	X	X	X	X	X	X	X
Employee health	X	X		X	X		X	X		X	X	X	
Employee health and the workplace design	X	X	X	X	X	X	X	X	X	X	X	X	X
Workplace design and implementation process		X								X	X	X	X
Gaps/shortcomings in current workplace design	X	X	X	X	X	X	X	X	X	X	X	X	X

Before-move Sites A & B

The following sections describe the before-move sites with site data including photos, floor plans and site attributes.

Before-move Sites A & B attributes

Attributes of the two before-move buildings are summarised side-by-side highlighting the many similarities in IEQ attributes of the two before-move sites. Similar elements were access to natural light and ventilation type. Site B accommodated 216 more people over an additional seven floors than Site A. Site B had accessible internal staircases connecting some floors, while Site A did not. Site B had extensive open water views while Site A had city and relatively closed views. Both buildings are classified as 'A Grade' based on the Property Council of Australia's 'A Guide to Office Building Quality [1] .

[1] These Office Building Quality guidelines for new and existing commercial office buildings have 13 categories: from hydraulics, security, amenities, parking through to environmental and base building attributes (Property Council of Australia 2019). Four ratings levels are available under the guidelines: Premium, Grade A, Grade B and Grade C. Grade A denotes a high-quality office building including high-quality views, outlook and natural light, high quality access, lift lobby, finishes and amenities.

Table 6.3: Comparison of building and interior attributes of before-move sites

Element	Site A	Site B	Data Source
Construction year	2001	2002	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Renovation to subject workplace	2015	2014	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Tenancy size	8,382 m^2. Levels 1,2,4	10,702 m^2. Levels 2,3,4,9,10,11,14,15, 16,17	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
NABERS (score out of a possible 6)	Energy: 6 Water: 4	Energy: 4.5 Water 4	NABERS (NSW Office of Environment and Heritage 2015)
Facades	51-75% Glass	51-75% Glass	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Views	North: city skyline. East, West & South: nearby buildings	North: city skyline. East: water views South & West: nearby buildings	Site observations
Individual workpoints			
Desking	All fixed height, no adjustments	All fixed height, no adjustments	Site observations & Interviews
Task chairs	Office chair with limited adjustments	Office chair with limited adjustments	Site observations
Training & messaging to occupants at move-in	Limited	Limited	Interviews
Ongoing ergonomic training	None	None	Interviews
Office layout			
Open offices & layouts	Partially open floor plan with limited private offices	Open-plan on all floors except executive floor. 5% ratio of private offices to total floor plan area	Site observations & floor plan analysis

Element	Site A	Site B	Data Source
ABW environment	not ABW	not ABW	Interviews
Desk assignment	Fully assigned – each person has a desk 796 desks for 504 staff	Fully assigned – each person has a desk834 desks for 720 staff	Interviews and (Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Accessible Internal stairs	No internal stairs connecting the occupants between floors. Fire Stairs only	Access between two floors via internal stair	Site observations & floor plan analysis
Indoor Environmental Quality			
Indoor Air Quality	HVAC Variable Air volume centrally controlled	HVAC Variable Air volume centrally controlled	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Thermal Comfort	Set at 23°C +/- 2°C all year round. No personal control systems	Set at 23°C +/- 2°C all year round. No personal control systems	(Building Occupant Survey System Australia (BOSSA) 2018a, 2018b)
Daylighting	80% of workstations are within 6-7 m from the glazed perimeter with direct access to views and outlook through windows	70% of workstations are within 6-7 m from the glazed perimeter with direct access to views and outlook through windows	Site observations & floor plan analysis
Office Lighting	Direct and fluorescent lighting	Direct and fluorescent lighting	Site observations
Acoustics and noise	Standard fitout with ceiling tiles and carpets floors have limited hard surfaces; some noise complaints from video conferencing at desk	Standard fitout with ceiling tiles and carpets; limited hard surfaces; no significant acoustic concerns reported	Interviews and site observations
Other elements			
Choice of location of work	Yes: can be negotiated with manager	Yes: can be negotiated with manager	Survey and interviews

Element	Site A	Site B	Data Source
Choice of flexible hours	Yes: can be negotiated with manager	Yes: can be negotiated with manager	Survey and interviews
Commuting time (one-way)	Mean = 41.48 mins	Mean = 49.3 mins	Survey
End of trip facilities in office building	Yes: reported problems with maintenance of facilities	Yes	Survey and interviews
Gym or active space access	Yes	Yes	Survey and interviews
Health programs	Yes	Yes	Survey and interviews

Both sites had a NABERS water rating of 4 out of a potential 6, which is 'best practice' and well above the industry standard of 3 (NSW Office of Environment and Heritage 2015). For the NABERS energy rating, both sites scored 4.5 out of 6 which compared favourably to the industry average of 4.1. The density of people per m^2 is often considered within the property and real estate industry. Site A has a density of 16.6 m^2 per person, and Site B has a density of 14.8 m^2 per person. These densities are higher than the reported current industry average of 18 m^2 per person (Jones Lang LaSalle 2017). The perception of high density was captured in this statement about Site A:

> *You feel like you are being jammed in like sardines, and you're just in a processing plant. ... You know they are doing it for cost-cutting (KI 418)*

As described in the Methodology, Walkscore is a measure of walkability to key public and social amenities. Both sites rated high on the Walkscore scale because of their location and proximity to services, 'world class public transport' and 'daily errands don't need a car' (Redfin Corporation, Seattle Washington).Site A was situated so that walking time to a bus or train was six minutes and one minute by bicycle and scored the maximum 100 points on Walkscore. Site B was situated so that walking time to a bus or train was eight minutes or two minutes by bicycle and scored 99 points on Walkscore.

Sites A and B have been introduced, and key building attributes compared. The following section presents details of each workplace separately.

Before-move Site A workplace

This Brisbane CBD office (Site A) accommodated approximately 40% of the organisation over three levels with no accessible connecting stairs (excluding locked fire stairs). The overall quality of the office provided a comfortable place for people to work in a convenient

location. Observations from site visits to Site A supported by photos and KI interviews, suggested Site A was acceptable workplace, although some KIs reported dissatisfaction by some users: ‘A lot of people complain about it’,’ and ‘It's really frustrating that you can’t come to work and feel comfortable’ (KI 418). Three KIs (218, 418 and 718) expressed dissatisfaction with the office’s temperature control and air quality. During site visits, some small desk fans were observed, indicating that some workers were seeking to change the conditions around their work area, which was confirmed by KI 418.

> *We feel the heat, but the air conditioning on this side's not that great, so a lot of us have desk fans. (KI 418 about Site A)*

Some KIs were involved in managing the office, providing an opportunity to discuss Site A’s thermal control. KI 318 noted difficulty with temperature control, as it was managed by base building air-conditioning systems.

Site A included three types of spaces: workstations, meeting rooms and breakout areas. The palette of materials and finishes was limited, with the effect that the site was monotonous. This was evident from interviews, observations and an analysis of the floor plan.

Figure 6.1: Site A typical floor plan with three space types

The lack of variety in individual workstations and shared and private spaces is typical of many office floor plans. This lack of variety was noted by one KI who commented on the lack of private spaces at Site A:

> *There wasn't any sort of different sorts of spaces for people to use. People often complained about the acoustics, particularly on the HR floor where there's that need for that higher level of confidentiality. (KI 418)*

As evident from the floorplan and photos all desk types were the same L-shaped 90° desk with partitions that ranged in height from 900-1,200 mm. With a length of 2,000-2,200 mm, the desks were large compared with the industry standard of 1,800 mm (Caloutti 2019).

When discussing the desking at Site A, KI 418 stated that HA desks were only provided following ergonomic assessments or for medical reasons that required a worker to stand during their workday.

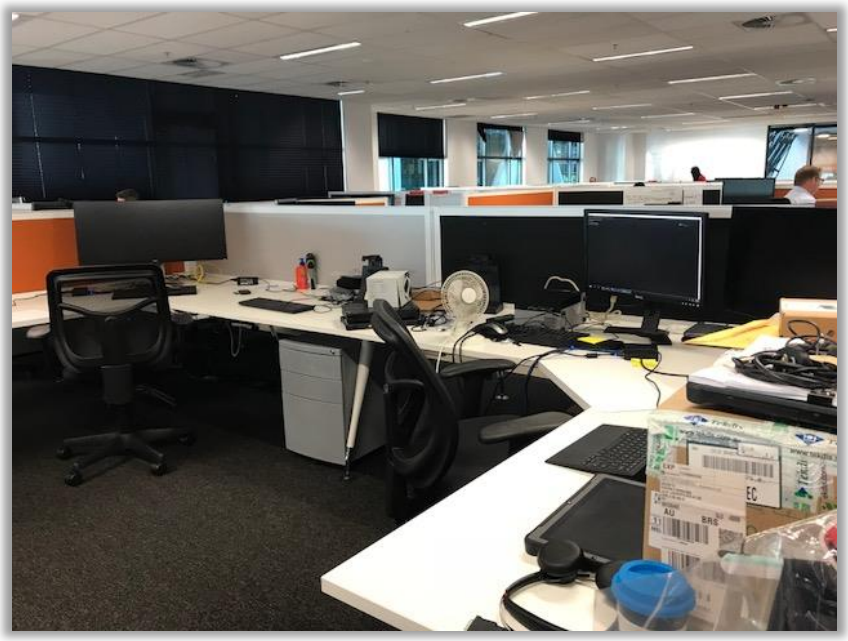

Figure 6.2: Chair and standard L-shaped desk with 1,200 mm high screens (Site A)

The layout and spacing of desks were in a linear formation. Corridors felt crowded at approximately 1,400 mm wide, which may be due to the between-desk partition screens being 1,200 mm high and the corridor-facing partition screens being 1,500 mm high).

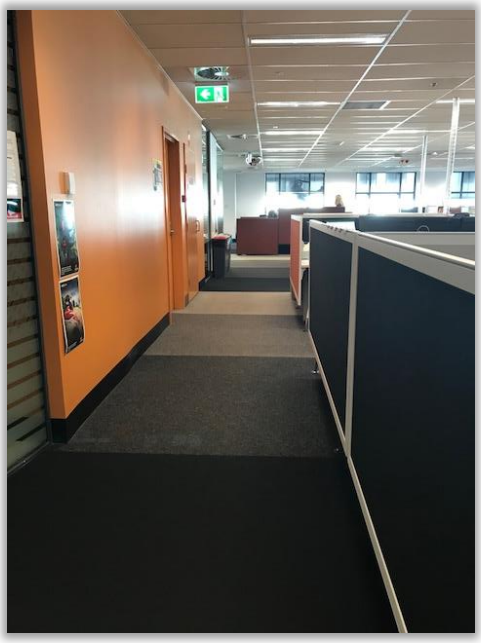

Figure 6.3: Partitions along corridors are 1,200 mm, limiting natural daylight into central spaces (Site A)

As shown on the floor plan and recorded in observations, all meeting and shared spaces were in the centre of the building's floor plate, resulting in collaborative and social spaces being windowless and uninviting As all meeting rooms were near the core of the building, access to views and daylight was only available to a few individuals seated at desks along the facade. While 80% of desks were within 6 m to 7 m of the building's perimeter and had daylight access, the partitions limited daylight penetration.

Figure 6.4: A common space on the inside of the building with no access to natural daylight (Site A)

When discussing organisational policies that affected their experience of the workplace, KI 418 from Site A confirmed that flexible work arrangements, including working from home, were permitted by agreement between the worker and their manager. KI 418 summarised the benefits of working from home:

> *People feel empowered and I think from a health point-of-view [the organisation] is doing this, it's almost saying – we get everyone's lives are different and coming to work five days a week is not practical anymore. (KI 418 about Site A)*

Furthermore, when discussed during four other interviews, KI 118, 218, 618 and 718 provided different information about the working-from-home policy, but most believed the organisation supported flexible arrangements.

Before-move Site B workplace

Site B was located in a waterfront Brisbane CBD building built in 2002 and accommodated approximately 700 staff over nine floors. Senior executive staff and management were located on dedicated floors and some floors connected by open accessible stairs. The

central core building design allowed for large column-free expanses and capitalised on the riverfront views with plenty of natural light, creating a high-quality occupant experience.

Site analysis indicated that Site B had similar building attributes to Site A, such as a limited variety of settings and layout; however, Site B had open river views and good natural light access:

> *And it's the visibility and light, I suppose, because you are right on the river. You get a beautiful view. Everyone likes to sit by the river, rather than the other side. They all like to be up in that river view. So that's one, the view. Secondly, I think it's the visibility. Having more natural light coming through with the bigger windows, etc. (KI 187 about Site B)*

Despite the more open layout at Site B than Site A, all desk types and meeting rooms were the same, with limited colours and finishes. Space types were limited to three options: desk, meeting room or kitchen areas (Figure 6.6).

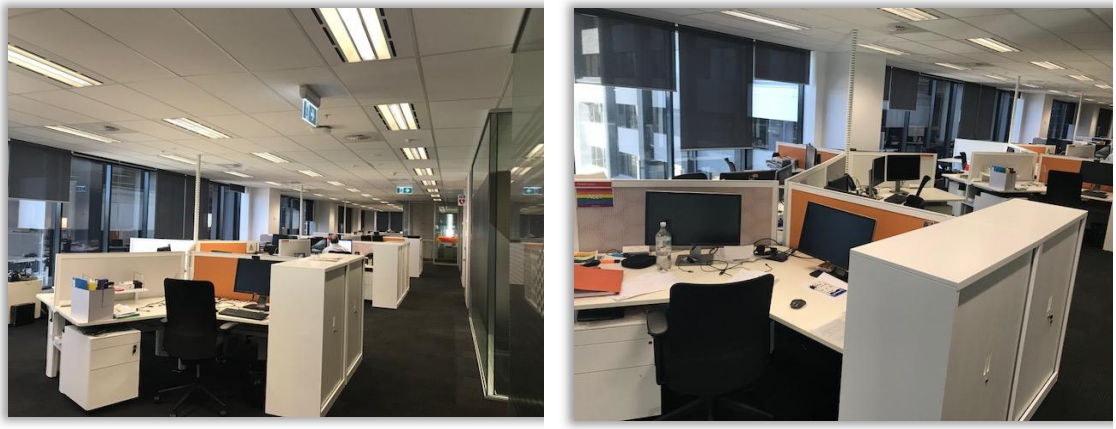

Figure 6.5: Site B has workstations consisting of individual chairs and desks with 1,200 mm high screens

As evident from the Site B floorplan (Figure 6.6) and photos from Site B individual desks were smaller than at Site A, 120° shape in configuration with 1,200 mm high screens. These features of the desk resulted in better overall visibility between workstations and across the floor at Site B, when compared to Site A. KI 618 identified similar shortcomings for Site B:

> *But I think the problem with these buildings is that they're all the same spaces, so if you want to do some focused work, it's very hard to sit at these desks and do that. Whereas these sorts of desks over at [Site C] with different settings, there it's easier to focus because you haven't got as much distraction around*

you and noise. Whereas sometimes it's difficult to sit at these desks without headphones and trying to ignore all the movements. (KI 618)

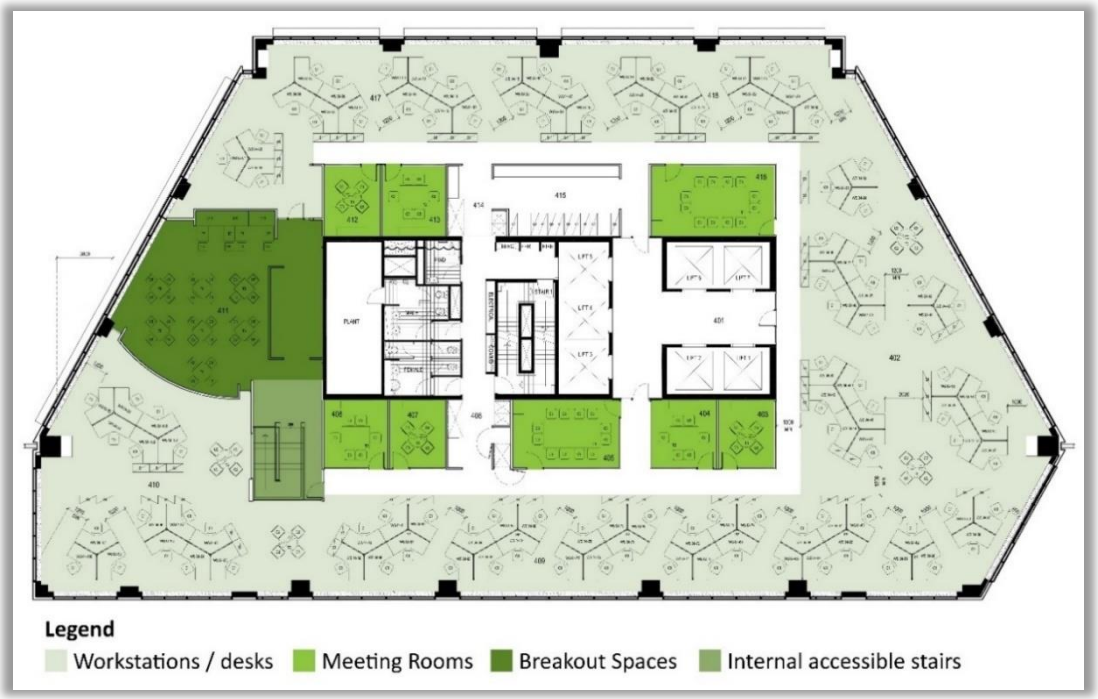

Figure 6.6: Typical floorplan of floors occupied by the organisation (Site B)

While Site B had some access to stairs (Figure 6.8), KI 118 noted, 'You don't have a fully interconnected stair that you can just pop down …, it's a downfall of the current [Site B]'.

Observations at both Site A and B recorded a basic office chair with limited possible adjustments, no sacral support, limited fixed lumbar support and no capacity to recline or move in it. Supporting this, KI 18 from Site B stated:

Ergonomics are not properly set up …, they have terrible chairs … they were just a straight back with no lumbar support. (KI 118)

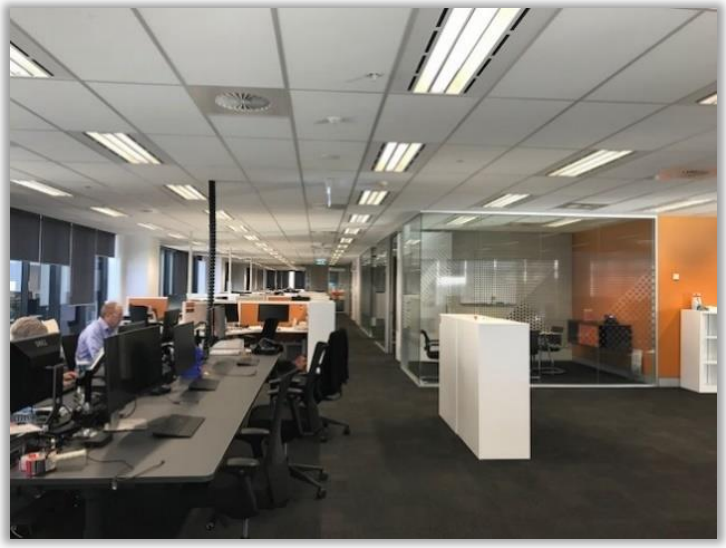

Figure 6.7: Site B trialled open desking without screens prior to the office move

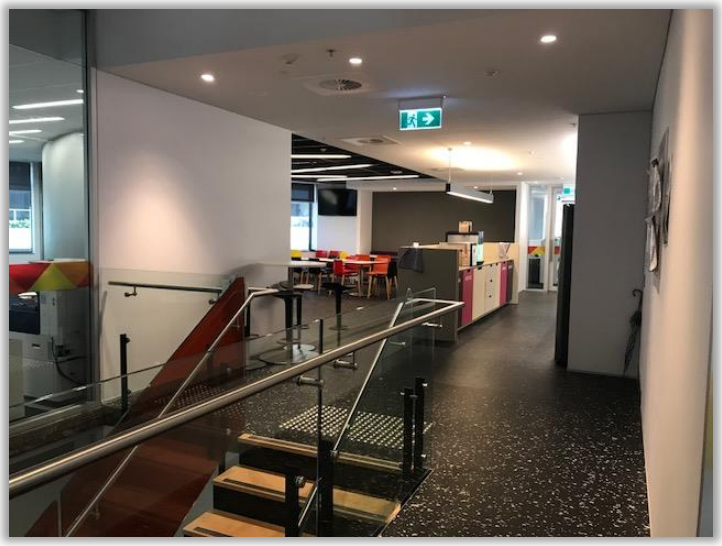

Figure 6.8: Site B had an internal staircase connecting some floors

ETF included showers, lockers and bicycle parking. One KI drew attention to the inadequacies of Site B's ETF and that this was frequently discussed by workers.

> *End-of-trip facilities is one of the big things that actually helps them have an exercise program or keep healthy. The organisation supports that by having that end-of-trip facility. The issue that we have is that we have a lack of lockers there so we've only got X number of people that can utilise that. (KI 318 on site B)*

Major interview themes identified for the before-move sites

As before-move workplaces, Site A and Site B were well-established, so interview discussions could focus on operational issues and existing conditions in the workplace and organisation. The before-move interviews were conducted to understand the positive and negative aspects of the before-move workplaces, and provide context for the survey data presented in the next chapter. Themes that recurred in the nine before-move interviews were identified using the template analysis method (Symon & Cassell 2012). The following descriptions illustrate the key themes using the KIs own words, transcribed from the interview recordings.

Locomotion Ltd.'s approach to health

Interviewees indicated that the general approach to employees' health before relocation emphasised safety and compliance with little attention to workers' broader well-being. Even when health programs were implemented, their availability and eligibility were unclear. The organisation's approach to health was summarised by KI 718 (project manager):

> *I think [health is] increasingly coming to the fore …, including mental health. … We are rapidly catching up, because I think as an organisation we're starting to recognise the importance, … There is a lot of talking about it, and a lot of separate elements, but I don't think its formed itself up into that whole program, but I think it will. (KI 718)*

Some KIs believed that health programs were not available to all workers because they primarily existed to attract future employees. Health programs identified by KIs included Quit Smoking programs, team sporting competitions and influenza vaccinations. Some felt that workers drove the organisation of health programs at the team level rather than such programs being part of an organisational strategy to support employee's health.

KI 518 (senior executive) shared their view of the company's stance on employee health when asked about health programs:

> *Social programs such as touch footy … are a bit more team-initiated rather than organisationally driven. In order of priorities, [health] is probably sitting at midfield at the moment. (KI 518)*

The flexibility of work location and work hours

Responses varied when discussing Locomotion Ltd.'s policy on workplace flexibility. Discussions with all KIs revealed that implementation of workplace flexibility was uneven. Two reasons were advanced: firstly, organisational policy on workplace flexibility was either unclear or not well communicated to staff. Secondly, the organisation did not have the necessary technology to provide to staff to work from home – this reason was mentioned

17 times during before-move interviews. The Project Manager involved in IT, KI 618, alluded to the importance of technology and mobility:

> *If you have a laptop and internet connection, … it creates options to work from home or in a quiet spot. … It creates flexibility that can help you manage your workload better. (KI 618)*

When asked whether this flexibility had an impact on people's health, KI 818 had a more measured view:

> *I think [impact on health] is probably mixed. People can operate quite effectively without being in the office … However, it probably introduces other complexity around their home environment and how it's set up for working. (KI 818)*

Empowerment derived from workplace flexibility was mentioned by KI 718 and KI 318, although KI 818 was aware of the downside: 'Now I can work anywhere, so you just expect to be able to contact me at all times.' KI 818 also pointed out the demand for flexibility of work location, especially from younger workers:

> *The workforce we are employing is getting younger, … demanding more mobile working, more flexibility in the way they work. … We can't actually attract those people without it. (KI 818).*

Location and end-of-trip facilities (ETF)

KIs 318, 418, 518 and 718 noted that Site A and B offices were well-located for public transport; however, they noted some operational problems with ETF that could affect workers' ability to actively commute. While facilities such as showers and a towel service were available, KIs 218, 518 and 718 explained the need for more lockers, noting a 'long waiting list for lockers' and 'lockers is the main thing'. Five of the nine KIs referred to a group of vocal employees that often complained about ETF access and operations. The five informants believed the complaints were disproportionate to the actual situation. Interestingly, KI 718 believed most of the workplace requests that could impact health were about ETF: 'Most of the time, it is end-of-trip facilities to allow them to use those active transport methods'.

In addition, the benefits of active commuting were summarised by a team manager:

> *Generally, you can see a more positive demeanour about those guys … Because they ride to work, they get the positive endorphins and don't usually get dragged down by the bump and grind of a big company. (KI 618)*

Ergonomic support

Ergonomic support for office workers is a factor in workplace health, so it was explored during interviews. Participants believed that ergonomic support was inadequate. KIs 118, 318, 418, 618, 718 and 818 thought that support for an ergonomic setup of desks and chairs was generally limited to those with medical requirements. KI 8 18 said that ergonomic setup was for those 'with medical issues … following an accident' and KI 818 stated it was implemented by the 'workplace rehab team'. It was also observed and that all desking was of fixed height, and task seating was suboptimal. Concerning ergonomic set-up for technology, KI 818 stated that it focussed on monitors and the computer mouse. Five of the nine KIs indicated that while ergonomic set-up was available, it was inadequate and would need improvement for the future workplace.

Thermal comfort

Interviews with KIs 318, 418 and 718 indicated that thermal comfort was an ongoing negative operational issue at Site A due to temperature variation across the floorplate. Thermal control was seen as rudimentary and base building-controlled, making it difficult for workers to adjust the temperature on their floor without contacting building management. For example:

> *There was air conditioning issues … We had a 'temperature gun', we call it. And you'd point it at the air … If someone reported it was too hot or cold, … we would then ask the building management to put it up or down. (KI 318 about Site A)*

Access to daylight

The amount of daylight at Site B was identified as a key positive element of the workplace and was mentioned by many interviewees. When asked, 'What elements do you think make a difference to occupant health in this workplace?', KI 718 summarised the difference between Sites A and B:

> *I think the location. It's on the river. There's really good natural light, because there's quite a lot of glass. If you're on the river side, it's probably better light-wise. It's not a bad place to work. It was nicely fitted out. (KI 718 about Site B)*

Limited variety of workplace settings

Spaces for quiet work were limited at both sites. KIs found it 'hard to focus' and a worker at Site A was concerned about acoustics:

> *The problem with this building is that they're all the same spaces, so if you want to do some focused work, it's very hard to sit at these desks and do that. (KI 618 about Site A)*

KI 18 described workspaces at Site B as

> *pretty inflexible … It tended to be - you were either at your desk or in a very traditional, conventional meeting room … People often complained about the acoustics. (KI 718)*

Limited opportunity for assessment of the workplace and of health programs

All KIs said that they were unaware of any measurement or benchmarking to assess the workplace and its impact on health. Satisfaction surveys took place on an ad hoc basis. Workers' absenteeism was reviewed only if a worker's performance was being evaluated. Opportunities for employees to provide feedback were also limited.

After-move Site C

Sites A and B were consolidated into a single site, Site C. This post-move workplace was seen as a considerable change for the organisation; interviewees saw many advantages of Site C over their previous workplace. The purpose of the after-move interviews was to understand the drivers of, and motivations for, the design and implementation of this workplace. Further insights from KIs, three of whom were interviewed at both stages, are provided below. KIs 219, 319, 519 and 1019 were available at the after-move Site C. Overall, the responses and conversations were positive. KI 219 Executive observed that, due to the move to Site C, 'absenteeism has dropped … I can't believe how low absenteeism is!' When compared to the before-move interviews, new themes emerged in the interviews conducted at the after-move workplace. The following themes were identified during the template analysis of the interview data.

<u>Interview themes: design and implementation of Site C</u>

The design intent

The relocation to Site C saw a fundamental shift in the organisation's approach to real estate and workplace to create a high quality, best practice office environment that focused on the health and well-being of employees. Site observations found a high-quality interior resulting in an improved experience overall. KI 719 encapsulated the aspirations of the after-move workplace:

> *We want to move to a culture … where you want people to go home healthier than they arrived … I think [the workplace] should enable people to make good choices, but I don't think it's [the organisation's] responsibility. (KI 719)*

A comment on the organisation's brief to the workplace designers was that the organisation

> *wanted people out of the seats and moving around, whether that was up or down or down to the lunchroom to have their lunch. That level of movement*

was fundamental, … was in the top three. So, I think that level of activity was the thing (KI 1019)

This described direction was further supported by KI 1019, who said that the real estate brief at Site C deviated from past briefs, as the

real estate accommodation strategy was financially driven [at Sites A and B]. [Site C] was people-driven. Health and well-being, culture and co-location are fundamental drivers for [Site C]

In five of nine interviews, attracting and retaining staff was put forward to explain the organisation's choice to design a healthy workplace. Furthermore, improving health was included in the design brief:

The big wellness around the world is greenery, water, and movement. Out of all the research we did, we got to those. The basis of what we wanted to develop in the workplace was water, greenery, and movement. (KI 219)

To develop the design brief, the organisation spent time and resources educating themselves about all aspects of best practice in workplace design. Their research included visiting many overseas workplaces and remaining closely engaged with those workplaces throughout the design and implementation process. KI 519 (senior executive) described some of the international offices viewed and how they addressed the health of employees:

We saw everything in our travels from Bloomberg in New York that basically have an open healthy canteen all day … There are also productivity upsides; …Employees being healthy means they're a lot more productive. (KI 519).

ABW strategy and improved mobile technology

Site C moved to a different type of workplace operation with the adoption of an ABW strategy. Occupants could move about during their workday to varied types of spaces and settings to suit their work tasks. For this ABW to be effective, all staff needed to be given a laptop that provided mobility within the workplace and beyond the office. KI 519 explains:

There's a lot more flexibility and people were given freedom by [company] to go elsewhere to do work, not just sit at the one desk all the time. (KI 519)

KI 519 also discussed the benefits of flexibility to move about to complete daily work more effectively:

I'm given flexibility to work in a way that best suits me with what I've got to do. …Even yesterday, I didn't want to be interrupted for an hour and a half so I just found a space and knocked it off. (KI 519)

Limited health promotion and communication of the new workplace strategy

Respondents reported that the organisation restructured concurrently with the office relocation, reducing overall communication and change management in the new after-move workplace. As three of the four KIs at Site C were employees, recent retrenchments and job security were discussed. The disruption resulting from restructuring and relocating concurrently was identified as the main reason for the lack of training on using the new ABW workplace:

> *Organisational change was quite significant and dramatic, … so we weren't able to communicate as overtly as we perhaps would have in a more stable environment, … not such a huge change management program, … jammed into three months. (KI 519)*

Three of the four interviewees identified a lack of communication about why and how to use elements in the new workplace. KI 519 believed that the 'air space' was insufficient to actively promote the new workplace's health benefits:

> *We haven't been able to actively get in front of and around promoting the health benefits of movement and water … We didn't have the time or energy or resources to really promote it hard. (KI 519)*

KI 1019 also observed a lack of change management and communication about the new workplace:

> *There was lots of people that moved in here without any understanding of what activity-based [working] was. (KI 1019)*

KI 219 said that Locomotion Ltd used an internal communication digital platform, 'Yammer', to provide information to workers about the new workplace. However, this communication format required active engagement – reading – for communication to be effective.

In KI 719's view, there was no 'formal policy' covering workers' well-being, although some health-based programs were available:

> *I wouldn't say there is a formal policy but there is a genuine push for health and well-being from HR. We have health checks available twice a year. (KI 219).*

KI 319 also addressed leadership's role in health promotion. When asked what would encourage people to make healthier decisions, KI 319 suggested that being proactive and having leaders set an example could change behaviours.

It's 'monkey see, monkey do' … If you are walking to a meeting with someone and they go to get into the lift, as a leader you can say 'Its quicker to take the stairs – let's take the stairs'. (KI 319).

Measurement and evidence to inform design decisions

The organisation project team had undertaken an informal research project internationally to identify exemplar workplaces. The intention was to gather information first-hand and see working examples of best practice. KI 519 explained the informal nature of it:

Most of it's been anecdotal … We found … read a lot of articles and opinion pieces … The most valuable evidence and data you can get is from speaking to the individuals themselves. (KI 519)

This description of data collection epitomises the process. Decision-makers were well-intentioned and became well-informed through their research; however, the quality of the information they accessed is unclear. Nor is it known how the information was disseminated to the interior designers and external consultants.

Systematic collection of objective data to inform the workplace design appears not to have occurred; the organisation relied on their designers for expertise. When asked about the use of evidence to inform the design of Site C, KI 1019 indicated that their evidence was their experience with past projects:

'[It] is a little bit formulaic because you know that obviously after doing [past project], kind of a few things like that … When you've got a project that, that's being delivered where it's really focused on that, you can actually have that opportunity to understand what worked well and what didn't work in that sense. (K1 1019)

Taking that level of understanding, experience about what does work and sort of applying that best practice across those major workplace solutions. (KI 1019)

Further dialogue during the interview with KI 1019 suggested that the 'lessons learnt' from past projects were collected and transferred informally, with no objective or benchmarked data that measured the success of the completed projects against proposed objectives, nor against other industry projects. Furthermore, despite this focus on health, KI 1019 noted that neither HR nor any health professionals were part of the design process:

HR didn't really play a great role … because they would've had a very much [safety] focus rather than health and well-being. (KI 1019)

Safety and compliance came first

Although a high priority, compliance with safety regulations was thought by several KIs to inhibit a design process that effectively incorporated health and well-being. Some interviewees observed that WHS representatives were sometimes excluded from design decisions and that this constrained the process in some way. Furthermore, KI 6 explained how the restructuring impacted the health focus:

> *Safety is definitely a big focus, … but downsizing means asking people to do more and more. … That's something that has taken a bit of focus away from health and well-being. (KI 619)*

After-move Site C attributes

The following table summarises the key features of the Site C building and office interior elements known to impact occupant health. At the time of data collection, BOSSA data were unavailable for Site C.

Table 6.4: Summary of building and interior attributes for after-move Site C

Element	Site C	Data Source
Year Constructed	2018	Interviews
Tenancy Size	11,686 over 8 floors	Interviews
Occupants	700*	Interviews
NABERS	5 star Energy rating	NABERS
Facades	All 51-75% Glass	Interviews
Views	North, East, South-open views with mixed user lower buildings. West- close buildings	Site observations & floor plan analysis
Individual workpoints		
Desking	70% of total 790 desks were HA desks where height adjustable (533)	Site observations & Interviews
Task chairs	Herman Miller Mirra chair- High quality Fully adjustable ergonomic chairs	Site observations
Training & messaging to occupants	Training in groups as part of induction program	Survey and Interviews

Element	Site C	Data Source
Office layout		
Open offices & Layouts	Open floor plan with variety of settings & spaces	Site observations & floor plan analysis
Density	16.6m2/person (based on 700 occupants)	Site observations & floor plan analysis
ABW environments	Mostly unassigned- shared desks 5-6% assigned	Interviews
Accessible Internal stairs	Prominent open connecting stairs-key designed element	Site observations & floor plan analysis
Indoor Environmental Quality		
Indoor Air Quality	HVAC Variable Air volume centrally controlled	Interviews
Thermal Comfort	Set 23 deg C +/- 2 deg C all year round. No personal control systems	Interviews
Daylighting	90% of workstations are within 6-7 m from the glazed perimeter with direct access to views and outlook through windows	Site observations & floor plan analysis
Office Lighting	Direct and Fluorescent lighting	Site observations
Acoustics and noise	Standard fitout with ceiling tiles and carpeted floors. Due to lower than expected occupancy and varied spaces, negativity about acoustics was limited.	Interviews and site observations
Other elements		
Choice of location of work	Yes- can be negotiated and agreed with manager	Survey and interviews
Choice of flexible hours	Yes- can be negotiated and agreed with manager	Survey and interviews
Commuting time	Commute time one way mean 50.7 minutes	Survey
End of trip facilities in office building	Yes. 153 bike spaces	Survey and interviews
Gym or active space access	No	Survey and interviews
Health programs	Information was not evident	Survey and interviews

** Due to restructuring occurring concurrently with the office relocation, exact employee numbers were changing at the time of data collection.*

Other metrics to note include the density of 16.6 people/m^2 for Site C, which is the same as Site A. A WalkScore of 99 was achieved for Site C from which there was a seven minutes' walk to the closest train and bus and a two minutes' cycle. Commuting time was considered by the organisation before relocation to Site C. KI 719 reported that 'postcode mapping' was done to understand the implications of relocation for employees.

The floorplans show how different after-move Site C was from Sites A and B. Site C had various types of workstations and varied meeting and collaboration spaces throughout the floor space. The floorplan shows the workstations in varied layouts, from which people could choose depending on what type of work they are doing – from open collaboration to concentrative quiet activities. Meeting and social spaces also varied in size, layout, amenities and format. Meeting and social spaces were located throughout the floorplate, allowing workers to choose an appropriate space for the type of work they were conducting.

Figure 6.9: After-move Site C typical floorplan with six setting types and stairs

KI 219 referred to six different types of work setting, but believed that, due to lack of training or change management communication, on using the ABW space, some of the informal spaces were not fully utilised. At the time of the after-move interviews, KI 1019

said she was working on a utilisation study and deciding how the setting could be improved to increase usage.

KI 219 observed that people chose to work in areas with more sun and light; and noted that the automatic sun-shading blinds were disliked because they reduced light penetration of the building. KI 519 noted that the amount of natural light was 'extraordinary'; the floor to ceiling windows 'bring in a huge amount of light, which creates a better vibe'. Site observations confirmed that sunlight access was a positive attribute in the workplace, especially near the open stair location. Being seated near the stairs because of better light may have encouraged stair use. KI 519 indicated that temperature control, another environmental element, was better in some locations, and that outdoor intake was higher than in the before-move offices.

Figure 6.10: Each floor had open communal spaces with natural light penetration from large windows, access to kitchen areas and access to internal open stairs (Site C)

Key designed elements described

KI 219 and KI 519 observed that three key design principles underpinned the design of Site C. These were movement, greenery and water. This is consistent with the site observations which noted a substantial internal staircase (encouraging walking) and many water points and plants (Figure 6.11). For example, KI 195 indicated 2,500 plants were included in the new design (Figure 6.13):

> *The interconnecting stair connects levels 5 to 12, promoting movement not just on the floor but through the whole building … added 2,500 plants and every floor has two water points. (KI 519 about Site C)*

Responding to the brief of ‘movement’, a significant internal staircase was a central element in the floorplate (Figure 6.11). In line with Fitwel guidelines, the intention was for employees to use the stairs as the main form of vertical transport instead of the lifts. KI 519 illustrated the design intent to encourage physical activity.

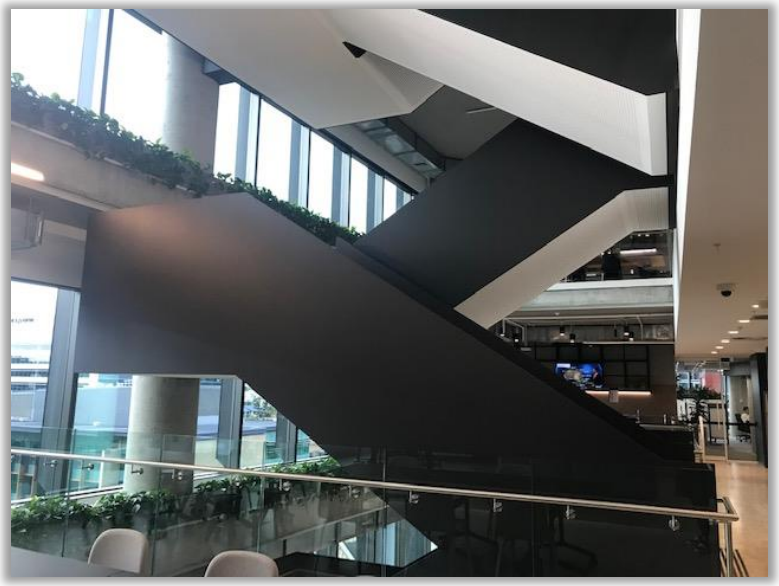

Figure 6.11: Significant, open and inviting stairs joined many of the floors together to encourage physical activity (Site C)

Analysis of the interview transcripts also confirmed that ‘movement’ or physical activity was a key consideration in the new workplace. While movement was only mentioned four times in the nine before-move interviews, it was mentioned 19 times in the four after-move interviews.

KI 519 discussed the key design driver, movement:

> *Through our research, one of the big drivers of health and well-being was movement through the building … So we have stairs connecting nine floors to promote people moving vertically through the building. (KI 519)*

Furthermore, the ability to choose where to work and move about the workplace was mentioned during several interviews, and when KI 119 was asked about how the workplace addresses health, the response was:

> *The biggest benefit will be the movement. And being able to move, to have the choice … giving people the choice. (KI 119 about Site C)*

KI 219 also observed that stress on the lifts was reduced as stair usage over one to two floors became more common.

At a more granular level when considering ‘movement’, the selection of both task chair and individual desk was subject to an extensive process, and the inclusion of clustered HA desking was observed (Figure 6.12). Desking type and layout were trialled and the internal workplace implementation team deliberated extensively on the proportion of HA desking to fixed height desking. KI 519 and KI 1019 indicated that the after-move workplace included 70% HA desking, creating options for standing throughout the day. Different layouts and HA workstations were installed in a trial space at Site B for employees to view and try out. Feedback on both the chair and desk was informal and provided to the internal workplace implementation team.

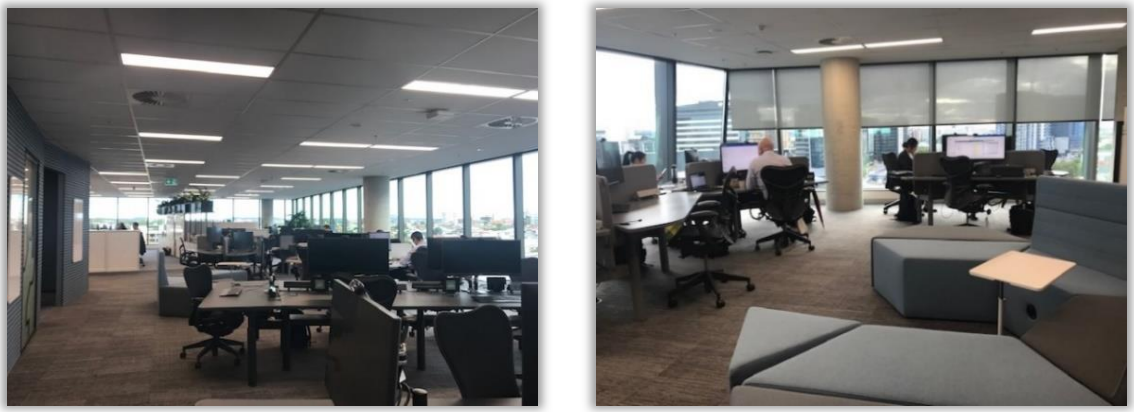

Figure 6.12: Workstation types varied in style, finish, layout and adjustability and were located with plenty of natural light and open views (Site C)

The other element ‘water’, and the inclusion of many water points to encourage hydration throughout the day, is described by KI 519:

> *We don't actually have what you might generally consider a kitchen on any floor other than our level five, so people are encouraged to move down to level five to a big kitchen … Water points is a big thing from health and well-being that we picked up in our research so every floor has two water points. (KI 519 on Site C)*

Finally, the inclusion of as many plants as possible was part of the brief and this was observed during site visits; this was in response to the ‘greenery’ or biophilic part of the design brief. While Figure 6.13 and Figure 6.10 illustrate some of the plantings, site observations revealed that plants could be seen from almost all points throughout the floorplate, suggesting occupants see the plants many times throughout their working day.

Figure 6.13: Plants feature extensively throughout Site C

Space planning also took into consideration spaces for health-related activities such as yoga. KI 219 described how one level had interconnecting spaces that could accommodate up to 200 people.

> *We built [open, large rooms] with health in mind … – opportunities for teams to get together and do yoga or pilates … It was definitely front of mind. (KI 219)*

KI 1019 suggested that a major focus of the design was efficiency to be achieved by implementing ABW to improve internal processes and communication.

> *[Locomotion Ltd] wanted to get efficiency and connect and engage through activity-based working; … the two key drivers are health and well-being and culture and connection' (KI 1019).*

Summary

The three workplaces and their attributes have now been analysed and described in detail. The key themes are emerging from template analysis of the interview data from design and operational perspectives providing an overall 'picture' of the sites' spaces and settings. The before-move sites were similar in overall environmental quality and in workers' responses to those environments. In contrast, the after-move site differed markedly as it was a newly-built ABW workplace focusing on health and well-being. The site analysis revealed differences in office layout and overall IEQ; a finding that was supported by the KIs' experience and responses. The interviews identified some building constraints such as the inability to control airflow and temperature at Site A and organisational constraints such as limited promotion of Site C's health-enhancing aspects. The use of formal evidence or

measurement tools to assess occupant experience and impact was lacking, which is not uncommon within the industry.

The following chapter provides the occupant perspective on these workplaces via the survey data.

Chapter 7 Results 2 – Survey results

Introduction

This chapter is the second of the two data chapters in this thesis and presents the data collected from the survey implemented before and after the office relocation. The first section presents comparisons between the before-move sites, Sites A and B, including the health status scores. The second section compares Cohorts A and B with the after-move cohort. The final section reports on workplace elements and their relationship to health status.

Survey participant profile

The before-move participants include those from Site A and Site B; response rates shown below.

Table 7.1: Before-move survey responses from Site A and Site B

Location	Surveys issued (N)	Responses (N, % total responses)	Response rate (%)
Site A	410	159 (52.1)	38.7
Site B	628	146 (47.8)	23.2
Total before-move	1038	305	29.3

Most participants were in the 31-50 age group, mid-level professionals working an average of 39.4 hours. The number of males and females was approximately equal. A detailed breakdown for Sites A and B can be found in Appendix Table 9.1 Demographics for before-move Site A and Site B

Table 7.2 Characteristics of the before and after-move survey participants

Characteristic	Before-move	After-move	Overall
Age (years)	N (%)	N (%)	N (%)
< 30	49 (16.1)	27 (12.2)	76 (14.4)
31 to 50	181 (59.3)	147 (66.2)	328 (62.2)
> 50	75 (24.6)	48 (21.6)	123 (23.3)
Total	305	222	527
Gender			
Female	150 (48.9)	98 (44.3)	248 (47.0)
Male	152 (49.5)	118 (53.4)	270 (51.1)
Not specified	5 (1.6)	5 (2.3)	10 (1.9)
Work role			
Administrative	47 (15.3)	35 (15.8)	82 (15.5)
Technical/ Supporting	59 (19.2)	56 (25.2)	115 (21.7)
Professional/ Mid-level	175 (57.0)	105 (47.3)	280 (52.9)
Managerial	23 (7.5)	23 (10.4)	46 (8.7)
Other	3 (1.0)	3 (1.4)	6 (1.1)
Hours worked (mean, SD)	38.8 (9.92)	40.3 (10.92)	39.4 (10.37)

Before-move survey

The online survey (Appendix A Before-move survey) was made accessible to participants via a link sent by email to all 1,038 employees located at the before-move sites A and B. Of surveys sent out, 430 were returned; 125 were discarded because they were incomplete, leaving 305 useable surveys. The response rate for the before-move survey was 29.3%.

Before-move Sites A and B BOSSA scores compared with BOSSA benchmarks

BOSSA benchmark data from occupant surveys (Building Occupant Survey System Australia (BOSSA) 2018a, 2018b) is included so that BOSSA scores for before-move Sites A and B can be compared with benchmark data. These scores were compared to benchmark scores from the larger BOSSA dataset and summarised below. Most dimensions for Sites A and B were above the BOSSA benchmark while the Overall Performance (health and productivity) scores were below the benchmark. As previously detailed, both Sites A and B were high quality A- grade buildings, the higher scores for air quality and thermal comfort are expected.

Table 7.3 Mean scores for Sites A and B and comparison to BOSSA benchmarks

IEQ dimension	BOSSA Benchmark (Mean)*	Site A BOSSA score (Mean)*	Site A score compared to BOSSA benchmark	Site B BOSSA score (Mean)*	Site B score compared BOSSA benchmark
Indoor Air Quality	4.3	5	+0.7	4.7	+0.4
Spatial Comfort	4.1	4	-0.1	4.2	+0.1
Overall Performance (health and productivity)	4.3	4	-0.3	4.1	-0.2
Thermal comfort	4.2	4.8	+0.6	4.5	+0.3

** Buildings score was obtained using a scale of 1 to 7*

Comparison of survey results for Sites A and B

As detailed in the Methodology chapter, Sites A and B datasets were analysed and statistically compared using Chi-squared tests for categorical data and Mann-Whitney U for continuous data. Respondents from each site were compared using the mean scores on each variable. For analysis of importance of health using a 7 point scale, 1 was 'not important at all' and 7 was 'highly important'. When rating Impact on Health, negative impact was the lowest score, 1, and 'significant positive impact' was the highest score, 5. The midpoint or 'neutral' response was 3. Scores of 4 and above were further analysed to determine any tendency in differences that did not reach statistical significance. Results were further broken down by age and gender (Appendix Table 9.9 Importance of elements by Gender- before-move).

Perceived Importance to Health of elements at Sites A and B

The differences between Sites A and B for Importance to Health were statistically significant for two elements: Access to Daylight and Access to Gym (Appendix Table 9.9 Importance of elements by Gender- before-move). Office lighting had the highest overall mean (6.1) and was the only element on which both Sites A and B recorded a mean above 6. Other elements that were highly rated in Importance to Health at Site A were Flexible Hours, Commute Time, Air Quality and Thermal Comfort. Participants at Site B focused more on IEQ, with high scores for Air Quality, Thermal Comfort, Access to Daylight and Office Lighting.

Table 7.4: Perceived Importance to Health of elements for Site A and Site B

Importance of Element	Site A Mean (SD)	Site B Mean (SD)	MWU	*p*-value	Overall Mean (SD)*
Individual Workpoint					
Desk	5.4 (1.43)	5.5 (1.46)	10400.5	0.300	5.5 (1.45)
Chair	5.7 (1.23)	5.8 (1.38)	10065.0	0.131	5.7 (1.32)
Office Layout					
Desk choice	3.4 (1.95)	3.7 (2.05)	10119.0	0.228	3.6 (2.01)
Office density	5.7 (1.13)	5.6 (1.45)	11008.0	0.835	5.6 (1.33)
Openness	4.9 (1.45)	5.0 (1.57)	10448.5	0.400	4.9 (1.52)
Setting Variety	4.3 (1.78)	4.6 (1.73)	10159.5	0.249	4.5 (1.75)
Stairs	4.6 (1.77)	4.4 (1.92)	10379.0	0.394	4.5 (1.86)
Indoor Environmental Quality					
Air quality	5.9 (1.18)	6.0 (1.25)	9948.0	0.185	5.9 (1.22)
Thermal comfort	5.9 (1.15)	6.1 (1.17)	9680.0	0.058	6.0 (1.16)
Daylight	5.8 (1.23)	6.1 (1.15)	9525.0	0.029**	6.0 (1.19)
Office lighting	6.0 (1.04)	6.1 (1.12)	9618.0	0.052	6.1 (1.09)
Acoustics	5.7 (1.35)	5.8 (1.41)	10422.0	0.346	5.8 (1.39)
Other elements					
Choice of work location	5.8 (1.36)	5.8 (1.48)	10486.5	0.601	5.8 (1.43)
Flexible hours	6.1 (1.15)	5.9 (1.58)	10827.0	0.761	5.9 (1.43)
Commute time	5.9 (1.31)	5.9 (1.37)	11070.0	0.966	5.9 (1.35)
End of Trip facilities	3.7 (2.39)	3.7 (2.34)	10966.5	0.955	3.7 (2.36)
Gym	4.3 (2.21)	3.5 (2.15)	8705.0	0.001**	3.8 (2.21)
Health incentives	4.6 (1.76)	4.4 (1.91)	10329.5	0.264	4.5 (1.85)

Note: Mean of a 1-7 scale where 1 is 'Not important at all' and 7 is 'Highly important'

** Overall Mean is mean of respondents in both Sites A and B*

*** Statistically significant. P value* ≤0.05

With regard to age effects, the people in the older age group were more likely to see access to stairs, thermal comfort, office lighting and acoustics as being of greater importance to health than younger age groups.. In the under-30s age group, flexible hours and commuting time were the most important workplace features, while in the oldest age group, ETF and Gym Access were of the least Importance to Health. Overall, ETF and Access to Gym were significantly different across the three age groups. The individual workpoint's Importance to Health was highest for those aged 30 years and under, while the workpoint's perceived Impact on Health is rated highest by those in the 50+ group (Table 7.7). When reviewing responses by gender, males rated the importance of all elements lower than females, except for ETF facilities (Appendix Table 9.9 Importance of elements by Gender- before-move).

Table 7.5: Perceived Importance to Health of elements for Site A and Site B by age

Importance of Element	30 years or under	31 to 50 years	Over 50 years	K-W	*p*-value
Individual Workpoint					
Desk	5.5 (1.45)	5.5 (1.44)	5.3 (1.48)	1.562	0.458
Chair	5.9 (1.32)	5.8 (1.38)	5.6 (1.19)	3.401	0.183
Office Layout					
Desk choice	3.6 (1.85)	3.7 (2.01)	3.5 (2.12)	0.265	0.876
Office density	5.7 (1.06)	5.7 (1.41)	5.4 (1.32)	4.068	0.131
Openness	4.9 (1.54)	4.9 (1.60)	4.9 (1.33)	0.516	0.773
Setting Variety	4.4 (1.85)	4.6 (1.73)	4.3 (1.78)	1.038	0.595
Stairs	4.1 (1.93)	4.5 (1.83)	4.6 (1.86)	1.984	0.371
Indoor Environmental Quality					
Air quality	6.0 (1.03)	5.9 (1.32)	6.0 (1.11)	0.077	0.962
Thermal comfort	5.9 (1.27)	6.1 (1.11)	6.0 (1.24)	0.694	0.707
Daylight	6.0 (1.16)	6.0 (1.23)	6.0 (1.12)	0.509	0.775
Office lighting	6.0 (1.15)	6.1 (1.11)	6.1 (1.03)	0.029	0.986
Acoustics	5.4 (1.62)	5.8 (1.34)	5.9 (1.35)	2.864	0.239
Other elements					
Choice of work location	5.7 (1.44)	5.9 (1.38)	5.6 (1.54)	2.611	0.271
Flexible hours	6.1 (1.26)	6.0 (1.48)	5.7 (1.39)	5.411	0.067
Commute time	6.1 (1.40)	6.0 (1.25)	5.7 (1.51)	5.803	0.055
ETF	4.1 (2.29)	3.9 (2.38)	3.1 (2.28)	6.481	0.039**
Gym	4.8 (2.00)	3.9 (2.19)	3.0 (2.15)	18.254	0.000**
Health incentives	5.0 (1.73)	4.5 (1.85)	4.2 (1.90)	5.099	0.078

Note: Mean of a 1-7 scale where 1 is 'Not important at all' and 7 is 'Highly important'

*** statistically significant P value* ≤0.05

Perceived Impact on Health of workplace elements for Sites A and B

Table 7.6 below presents the data on the perceived 'impact' of various workplace elements on workers' health (as opposed to 'importance' to health presented). Taken as a whole, respondents saw Access to ETF and Flexible Hours as having the most impact on their health. Individual workpoints (desk and chair) had the least impact and were statistically significant for Impact on Health. Respondents' workplace (Site A or Site B) influenced their rating of particular elements' impacts on their health. These were the Chair, Desk, Winter Thermal Comfort and Access To Daylight. Despite both sites having different levels of stair access, there was no significant statistical difference between the sites on respondents' ratings of the impact of Stair Access on their health.

Table 7.6 Perceived Impact on Health of workplace elements for Site A and Site B

Impact of Element	Site A Mean (SD)	Site B Mean (SD)	MWU	*p*-value	Overall Mean *(SD)
Individual Workpoint					
Desk	2.5 (0.91)	2.3 (0.85)	9484.0	0.025**	2.4 (0.88)
Chair	2.8 (1.09)	2.4 (0.98)	8908.0	0.002**	2.5 (1.04)
Office Layout					
Desking arrangement	3.1 (1.06)	3.1 (1.06)	10695.0	0.784	3.1 (1.06)
Layout	2.9 (0.82)	2.9 (0.80)	10563.0	0.309	2.9 (0.81)
Stairs access	2.7 (0.98)	3.0 (1.06)	3114.0	0.055	2.8 (1.02)
Kitchen/bathroom proximity	3.2 (0.53)	3.1 (0.59)	10748.5	0.352	3.1 (0.56)
Indoor Environmental Quality					
Indoor environment Quality	2.7 (0.81)	2.6 (0.91)	10518.5	0.300	2.6 (0.87)
Air quality	2.8 (0.72)	2.7 (0.76)	10237.0	0.162	2.7 (0.75)
Winter temperature	2.7 (0.75)	2.4 (0.86)	9391.0	0.012*	2.5 (0.83)
Summer temperature	2.7 (0.87)	2.6 (0.89)	10958.0	0.679	2.6 (0.88)
Daylight	3.1 (1.11)	3.4 (1.12)	9041.5	0.005**	3.3 (1.13)
Office lighting	2.9 (0.93)	3.1 (0.96)	10245.0	0.155	3.0 (0.95)
Acoustics	2.5 (0.91)	2.6 (0.88)	10309.5	0.186	2.5 (0.89)
Other elements					
Choice of work location	3.5 (1.04)	3.4 (1.20)	10946.5	0.833	3.5 (1.14)
Flexible hours	4.0 (1.18)	3.9 (1.25)	10610.5	0.517	3.9 (1.22)
Commute time	2.8 (1.13)	2.6 (1.23)	9868.0	0.097	2.7 (1.19)
End of Trip facilities	4.7 (1.34)	4.4 (1.34)	9905.0	0.097	4.5 (1.34)
Gym access	3.3 (1.17)	3.4 (0.92)	10686.0	0.542	3.4 (1.02)
Health incentives	3.3 (1.06)	3.4 (0.97)	9859.5	0.085	3.4 (1.01)

Note: Mean of a 1-5 scale where 1 is 'Significant negative impact' and 5 is 'Significant positive impact'.

** Overall Mean is mean of respondents in both Sites A and B*

*** Statistically significant P value* ≤0.05

For Thermal Comfort in summer and winter, the Impact on Health was rated higher at Site A than Site B, with a mean score of 2.7 for both winter and summer temperatures. Site B reported a significantly lower score of 2.4 for winter temperatures. The final element of the indoor environment that was examined was noise or acoustics which rated the lowest mean score of 2.5.

Certain organisational practices or policies that influence the workplace experience were seen to impact workers' health. Certain factors beyond the office, ETF, Flexible Work Hours and Choice of Work Location were seen to have the most impact (Table 7.6).

Responses on 'Impact on Health' for these elements were on average the same or higher for males than females. Exceptions were Proximity to facilities, Flexible Hours, and Access to Gym (Appendix Table 9.10 Impact of element by Gender- before-move).

Table 7.7 below shows some difference between age groups for perceived Impact on Health for some elements. For example, the largest difference between age groups was for the Choice of Work Location. Workers aged under 30 found this to have less impact on their health (Mean 3.1) than those aged over 50 years (Mean 3.6). For the under-30s and over 50s, ETF was judged to have the greatest impact on their health. For 31 to 50s, Flexible Hours rated as the greatest impact on health.

Table 7.7 Perceived Impact on Health of workplace elements for Site A and Site B by age

Impact of Element	30 years or under	31 to 50 years	Over 50 years	K-W	*p*-value
Individual Workpoint					
Desk	2.2 (0.90)	2.4 (0.88)	2.5 (0.86)	5.883	0.053
Chair	2.5 (1.00)	2.4 (0.99)	2.7 (1.18)	3.756	0.153
Office Layout					
Desking arrangement	3.1 (1.01)	3.1 (1.07)	3.1 (1.08)	0.374	0.829
Layout	3.0 (0.85)	2.8 (0.76)	3.0 (0.88)	4.241	0.120
Stairs access	2.7 (0.75)	2.8 (1.03)	2.9 (1.11)	0.076	0.963
Kitchen/bathroom proximity	3.2 (0.59)	3.1 (0.56)	3.2 (0.57)	0.932	0.628
Indoor Environmental Quality					
Indoor environment Quality	2.4 (0.87)	2.6 (0.86)	2.8 (0.90)	3.603	0.165
Air quality	2.5 (0.74)	2.8 (0.77)	2.7 (0.70)	5.194	0.074
Winter temperature	2.5 (0.87)	2.5 (0.89)	2.6 (0.64)	1.856	0.395
Summer temperature	2.5 (0.87)	2.6 (0.92)	2.6 (0.80)	1.607	0.448
Daylight	3.2 (0.99)	3.3 (1.19)	3.4 (1.06)	0.749	0.688
Office lighting	2.8 (0.93)	3.0 (0.99)	3.1 (0.87)	3.754	0.153
Acoustics	2.8 (0.90)	2.5 (0.89)	2.5 (0.90)	5.049	0.080
Other elements					
Choice of work location	3.1 (1.05)	3.5 (1.17)	3.6 (1.05)	7.355	0.025**
Flexible hours	**3.9(1.27)**	4.0 (1.19)	3.8 (1.24)	1.208	0.547
Commute time	2.8 (1.21)	2.6 (1.17)	2.8 (1.26)	1.169	0.557
End of Trip facilities	4.7 (1.35)	4.5 (1.34)	4.5 (1.36)	0.791	0.673
Gym access	3.3 (1.13)	3.5 (1.01)	3.2 (0.96)	4.298	0.117
Health incentives					

Note: Mean of a 1-5 scale where 1 is 'Significant negative impact' and 5 is 'Significant positive impact'.

***Statistically significant P value* ≤0.05

The following sections will elaborate on the survey responses above and explore the detail of responses to Individual workpoint, Office layout, IEQ and Other elements. The sections below will follow the order of the survey.

Individual workpoint (desk and chair)

The individual workpoint included the desk and chair available within the office space. The vast majority of respondents (92.4%) from both sites report having fixed-height desks, confirmed by site observation. For the 29 respondents who had a HA desk, the average reported standing time was 75 mins.

Whether training had been provided in the use of the chair was significantly different between Site A and Site B with reports of training having been provided at Site A more frequently than for Site B. Over a third of all respondents reported that training had been provided online and a third reported that training was provided individually. Other types of ergonomic training included ergonomic assessments, training in respondent's previous job and external advice from health practitioners.

Table 7.8 Types of ergonomic chair training

Chair training types	Site A N (%)	Site B N (%)	X^2 (df)	*p*-value	Overall N (%)
Chair training	66 (55.0)	58 (31.2)	17.16 (1)	0.000**	124 (40.5)
Chair training - written	20 (30.3)	15 (25.9)	0.301 (1)	0.584	35 (28.2)
Chair training - online	26 (39.4)	22 (37.9)	0.028 (1)	0.867	48 (38.7)
Chair training - individual	19 (28.8)	17 (29.3)	0.004 (1)	0.949	36 (29.0)
Chair training - group	13 (19.7)	8 (13.8)	0.765 (1)	0.382	21 (16.9)
Chair training - other	4 (6.1)	10 (17.2)	3.853 (1)	0.050	14 (11.3)

***Statistically significant P value* ≤0.05

Office layout

While the overall layout of Sites A and B differed, there was no statistically significant difference in the reported Health Impact and Importance of the two sites' layouts. When describing the layout of the work area, two thirds of the respondents (Site A: 62.8% and Site B: 66.4%) reported working in an open-plan area with partition screens lower than 1.5 metres. At Site B, only seven respondents reported having, or sharing, a private office and only one for Site A (Appendix Table 9.3 Description of office settings at Site A and Site B).

Elements beyond the office

As a holistic perspective is taken in this research towards the impact of the workplace on workers' health, the survey also collected data on elements outside the physical workplace design that impact peoples' health. These elements are Flexible Hours, Flexibility of work location, commuting time, ETF, Access to gym, Incentives to being healthier.

When considering flexible hours, most respondents viewed this policy as having a positive impact on their health; slightly less than half indicated that the positive health impact was 'significant'. There was no significant difference between Sites A and B. Respondents were asked whether their organisation supported flexible work hours. Organisational support for flexible work hours was statistically significantly different between Sites A and B (p = .011). At Site B, responses were fairly evenly divided between those who thought that flexible hours were an organisation-wide arrangement (37.0%) and those who thought it was arranged within their team (40.3%). This pattern was different at Site A, where a greater proportion indicated that flexible work hours was arranged within their team (48.8%) rather than being an organisation-wide arrangement (32.3%) (Appendix Table 9.21 Health choices and flexibility- Site A and Site B). These survey results suggest a degree of organisational support for flexible hours, which is consistent with the views of the KIs in the interviews.

Respondents were given the opportunity to answer an open-ended question on the flexibility of work hours. This open-ended question garnered the largest number of responses to open-ended questions in the survey (n = 163). This compares with an average of fewer than 30 responses for the other open-ended questions. Responses were both positive and negative, covering topics including possible reduced productivity and improved work-life balance: 'My managers don't really support it'; 'It's not applied consistently'; 'Helps with stress of managing work and kids etc'; and 'Massive positive impact on my health and happiness'.

Respondents were asked questions about the flexibility in where they could work from. Most respondents (61.2%) in the before-move survey indicated that they had 'some flexibility in location' of work, while around one-third (32.2%) indicated that they had no choice of work location and needed to be in the office during work hours. Being able to choose their location of work was seen as having a positive impact on health: just under half of the respondents (46.6%) indicated that location flexibility had a 'significant' or 'minimal' positive health impact.

The time taken to commute to work varied widely, with one participant commuting four hours a day. The average one-way commute was 45.4 mins. Commuting time did vary by age with under-30s mean commute time being 43 minutes, 45.7 minutes for 31-50s and 48 minutes for over 50s. Return trip times ranged from 82 mins to 98 mins. The majority of respondents viewed commuting time as having little impact on their health; 38.3% indicated that commuting had a small negative impact and 25.3% indicated that the impact was neutral (p = .124). The inclusion of ETF enables workers to wash after their trip and change into work clothes. Well over half of the respondents (70.2%) indicated that they used their

building's ETF. This element had the highest mean scores of all workplace elements in all age groups (Table 7.7, p.137).

Access to Gym Facilities was different at Sites A and B. Nearly three-quarters of respondents (72%) from Site B said they had access to a gym, and this number was much lower at Site A (42%). Just over half of respondents (55.7%) rated Gym Access as 'neutral' with regard to its impact on their health, and a positive impact was reported by about a third of respondents – 11.1% rated gym access as having a minimally positive impact and 20.7% rated it as having a significant positive impact.

The final question in Section two of the survey asked about opportunities provided by the organisation to improve their employees' health, such as health promotion programs. Just under half (47.4%) reported that health incentives such as gym membership were offered and just over half (52.6%) reported no such incentives (p = .206). Almost half of the respondents (48.9%) indicated that incentives to improve health provided by the organisation had a no impact or a 'neutral' impact on their health.

Before-move satisfaction with elements of the work area

Respondents were asked to rate their satisfaction with three elements of the workplace (such as the desk and chair), Layout, and IEQ. Means for satisfaction were around the midpoint (scored as 3), suggesting a neutral or 'neither satisfied nor dissatisfied' response. Close to a third of respondents (30.9%) reported being 'neutral' with regard to satisfaction with their office IEQ, and 37.5% were 'somewhat unsatisfied'. No statistically significant difference was found between Sites A and B.

Table 7.9: Satisfaction with work area for Site A and Site B

Element of work area	Satisfaction (mean of score on 5-point scale)				
	Site A Mean (SD)	**Site B Mean (SD)**	**MWU**	***p*-value**	**Overall Mean (SD)**
Furnishings (e.g., desk and chair)	**3.1 (1.13)**	**3.0 (1.18)**	**10679.000**	**.509**	**3.1 (1.16)**
Layout	**3.0 (1.07)**	**3.1 (1.07)**	**10495.000**	**.295**	**3.1 (1.07)**
IEQ	**2.9 (1.01)**	**2.7 (0.97)**	**11029.500**	**.823**	**2.8 (0.99)**

Age impacted satisfaction with the work area; the level of satisfaction was highest in the 50+ age group and lowest in the under-30s age group. The 30-50 years group's satisfaction was part-way between these (Appendix Table 9.11 Satisfaction by Age- before-move). Men were more satisfied with the IEQ of their office environment than women (means of 2.9 and 2.7 respectively). Though small, this difference was statistically significant (p =.023).

Physical activity at before-move sites, A and B

Many workplace elements had the potential to enable or encourage office workers to move about during their workday and increase physical activity. These elements are stairs, HA desking and opportunities to stand rather than sit. The extent to which respondents indicated that they availed themselves of these opportunities shown by the number of times workers used the stairs each day, time spent standing at their desk and time spent sitting at their desk.

Table 7.10: Workplace-based physical activities at Site A and Site B

Physical activity	Site A Mean (SD)	Site B Mean (SD)	MWU	*p*-value	Overall Mean (SD)
Standing at desk (mins)	106.7 (100.87)	60.6 (76.11)	60.5	0.161	74.9 (85.50)
Stair use (times per day)	0.5 (0.90)	1.2 (1.57)	385.5	0.079	1.2 (1.53)
Sitting at desk (mins)	334.4 (174.44)	428.4 (180.87)	65.5	0.323	398.2 (181.17)

Settings that allow people to stand at their workpoint contribute to reduced sitting and sedentary time. The majority of respondents from Sites A and B indicated that they had fixed desking that would preclude standing to work at their desk. Males stood for longer than females, and this difference was statistically significant (p = .042). For females, the mean standing time was 43.6 mins (in a 7.5-hr workday), and for males, the mean was 99.5 mins (in an 8-hr workday) (Appendix Table 9.13 Activity by Age- before-move).

For Site B respondents, whose site included an internal staircase between some floors, half reported having access to stairs which they used on average 1.2 times per day. For Site A, with only fire stair access, 10% of respondents reported access to stairs which they used on average every two days. Overall, most participants saw stair access as having a marginally negative impact or no impact on their health. About 20% viewed stair access as having a positive impact on their health, although most of those rated the impact as ‘minimal’. As age increased, the impact and importance on health of stair access increased.

As shown below some age-related differences in sitting time were found. The under-30s age group reported a sitting time of 9.5 hours per day with a large standard deviation of 212 minutes, despite reporting working only 7.68 hrs per day. This discrepancy suggests inaccuracy in self-reporting of sitting time. On the other hand, the over-50s group reported a sitting time of 5.8 hrs which is 71% of their average workday (8.16 hrs). It should be noted that only those assessed with medical need could access a HA desk.

Table 7.11: physical activity times by age group at before-move sites A and B

Physical activity	Age (years)				
	≤30	31-50	>50	K-W*	*p*-value
Standing at desk (mins)	0.0 (0.00)	83.1 (92.19)	71.0 (66.30)	4.027	0.134
Sitting at desk (mins)	570.0 (212.13)	395.5 (197.10)	350.0 (77.46)	2.280	0.320
Stair use (times per day)	0.9 (1.23)	1.1 (1.36)	1.6 (2.04)	1.011	0.603

**Kruskal-Wallis (KW) point estimate*

Average work hours per day at before-move sites is 7.76 hrs/day (465.6 minutes/day).

SF-12 health status of participants at before-move sites A and B

This survey used the SF-12 to determine the health of respondents. Table 7.12 below summarises the SF-12 scores and shows no statistically significant difference between Site A and Site B. This table also shows a higher physical score and lower reported sick days at Site A.

Table 7.12: Weighted scores on the SF-12 for combined sites A and B

SF-12 score	Site A Mean (SD)	Site B Mean (SD)	MWU	*p*-value	Overall Mean (SD)
SF-12 Physical Score	52.6 (6.58)	51.2 (8.05)	9781.5	0.286	51.8 (7.53)
SF-12 Mental Score	48.7 (10.09)	48.1 (10.57)	10096.5	0.526	48.3 (10.38)
Number of sick days*	4.8 (2.64)	6.1 (8.70)	37.5	0.703	5.8 (7.35)

**Sick days reported from survey*

For each component of the SF-12, the number and percentage of respondents who were either below the norm, close to the norm, or above the norm is shown below. Scores below the norm indicate respondents had worse physical and/or mental health than the norm, and scores above the norm indicate better physical and/or mental health. More than half the cohort (54.4%) was above the norm for the physical health score which exceeded the mental health scores which were also above the norm, but to a lesser extent (43.6%). These results indicate that most respondents were in good health and that their health did not negatively impact their daily lives.

Table 7.13: SF-12 scores compared with community norm scores in the before-move cohort

SF-12 scores	Site A N (%)	Site B N (%)	X^2 (df)	*p*-value	Overall N (%)
SF-12 Physical Composite Score					
≤ 0.3SD below norm	17 (14.7%)	39 (21.4%)	2.136 (2)	0.344	56 (18.8%)
Within 0.3SD of norm	33 (28.4%)	47 (25.8%)			80 (26.8%)
≥0.3SD above norm	66 (56.9%)	96 (52.7%)			162 (54.4%)
SF-12 Mental Composite Score					
≤ 0.3SD below norm	42 (36.2%)	71 (39.0%)	1.978 (2)	0.372	113 (37.9%)
Within 0.3SD of norm	18 (15.5%)	37 (20.3%)			55 (18.5%)
≥0.3SD above norm	56 (48.3%)	74 (40.7%)			130 (43.6%)

When considering age groups, Table 7.14 below indicates a decline in the physical health scores with age and an increase in the mental health score with age. There were no significant differences in the SF-12 scores by age group.

Table 7.14: SF-12 scores of before-move cohorts by age

SF-12 scores	Age (years)				
	≤30	31 - 50	>50	K-W	*p*-value
Physical Composite Score (SD)	53.6 (4.42)	51.6 (7.83)	51.0 (8.36)	1.478	0.477
Mental Composite Score (SD)	45.3 (11.37)	48.6 (10.14)	49.7 (10.12)	5.384	0.068
Sick days	4.4 (1.52)	6.5 (9.09)	4.0 (1.41)	0.245	0.885

After-move survey

The after-move survey was conducted 10 months after the workers from Sites A and B moved to Site C. The workplace, Site C, had been specifically designed and constructed by the organisation to accommodate this workforce.

The after-move survey was identical to the before-move survey except for the addition of a question to identify the before-move location of the respondent (Appendix B After-move survey). Of the 790 people invited to complete the online after-move survey, 208 returned completed surveys, a response rate of 29.7%. The response rate accords with previous research and provides enough data for the purposes of this study as calculated in the Methodology Study sample . The composition of the after-move sample was consistent with the proportion of workers in Sites A and B; approximately 40% in Cohort A and 60% in Cohort B.

Chi-squared tests were used for categorical data and Mann-Whitney U for continuous data. The after-move responses of Cohort A and Cohort B (who shared a common workplace)

were compared, followed by an analysis of differences between before-move data (from combined Sites A and B) and after-move data (Site C).

Comparison of Cohort A and Cohort B in their new workplace (Site C)

Noteworthy differences between the two cohorts when surveyed at Site C include:

- a larger proportion of males in Cohort A compared to Cohort B (65.1% vs 46.3%, p = .014)
- Cohort B rated several items higher than Cohort A in:
    - the importance of Access to Stairs (mean 4.6 vs 4.0, p = .019).
    - the importance of health incentives (mean 4.7 vs 4.1, p = .014).
    - the Impact on Health of Access to Gym (mean 3.3 vs 3.0, p = .033).
    - the Impact on Health of health incentives (mean 3.3 vs 3.1, p = .031).
- a larger proportion of Cohort B reported access to stairs (73.2% vs 34.9%, p < 0.001).
- more respondents from Cohort B reported moving desks in the ABW environment than those in Cohort A (87% vs 76.2%, p = 0.001).

There were no other statistically significant differences between Cohorts A and B at Site C. However, differences were found for both cohorts in their before- and after-move survey responses; these are reported separately and described below.

Comparison of before- and after-move for Cohort A

Perceived Importance to Health of Site C's workplace elements for Cohort A: The table below presents the results for Importance to Health on the before- and after-move surveys for Cohort A. The effects of Access to Stairs, Air Quality and Flexibility of Work Location on Importance to Health differed before and after the move (p = .036, p = .035 and p = .006, respectively). Changes across the before- and after-move surveys in the perceived importance of workplace elements to health were not influenced by the respondent's Age, Gender, Work Role or Weekly Work Hours.

While most elements were seen as contributing to health more after the move, Access to Stairs was the only element that was seen to be of less importance, and this difference was statistically significant. Cohort A had not had stair access at the before-move Site A, yet only about one-third of Cohort A (34.9%) reported having stair access at Site C, despite the stair being a prominent feature of the workplace (Appendix Table 9.40 Health facilities-Cohort A- before and after-move).

Table 7.15: Mean scores of Importance to Health of elements for Cohort A before and after-move

Cohort A- Importance of Element	Before Move Site A (n=121) Mean (SD)	After Move Site C (n=84) Mean (SD)	MWU	*p*-value
Individual Workpoint				
Desk	5.4 (1.43)	5.6 (1.29)	4672.0	0.360
Chair	5.7 (1.23)	5.9 (1.22)	4492.5	0.169
Office Layout				
Desk choice	3.4 (1.95)	3.9 (1.9)	4248.5	0.087
Office density	5.7 (1.13)	5.8 (1.34)	4550.0	0.218
Openness	4.9 (1.45)	5 (1.69)	4407.0	0.183
Setting variety	4.3 (1.78)	4.4 (1.78)	4841.0	0.699
Stairs	4.6 (1.77)	4 (1.95)	4144.0	0.036**
Indoor Environmental Quality				
Air quality	5.9 (1.18)	6.2 (1.1)	4054.0	0.035**
Thermal comfort	5.9 (1.15)	6.2 (0.94)	4270.5	0.060
Daylight	5.8 (1.23)	6 (1.18)	4540.0	0.241
Office Lighting	6 (1.04)	6.2 (0.95)	4377.0	0.174
Acoustics	5.7 (1.35)	6 (1.22)	4322.0	0.069
Other elements				
Choice of work location	5.8 (1.36)	6.2 (1.09)	3891.5	0.006**
Flexible hours	6.1 (1.15)	6.3 (0.98)	4447.5	0.119
Commute time	5.9 (1.31)	6 (1.25)	4940.5	0.798
End of trip facilities	3.7 (2.39)	3.7 (2.13)	4994.0	0.992
Gym	4.3 (2.21)	4 (2.15)	4567.5	0.248
Health incentives	4.6 (1.76)	4.1 (1.91)	4248.5	0.052

Note: Mean of a 1-7 scale where 1 is 'Not important at all' and 7 is 'Highly important'

*** Statistically significant*

Perceived Impact on Health of Site C's workplace elements for Cohort A**:** When rating the Impact on Health of workplace elements, seven elements showed statistically significant increases between Site A and Site C in the responses by Cohort A (**Error! Reference source not found.**). These were the desk, chair, IEQ, office lighting and flexibility of work location. Desking arrangement and temperature experienced in winter were seen to have less impact on health when assessed at the after-move workplace than when assessed at the before-move workplace. The age, gender, work role and weekly work hours of Cohort A did not affect perceived changes in health impact.

Table 7.16 Mean scores of Impact to Health of elements for Cohort A before and after-move

Cohort A Impact of Element	Before Move Site A (n=121) Mean (SD)	After Move Site C (n=84) Mean (SD)	MWU	*p*-value
Individual Workpoint				
Desk	2.5 (0.91)	3.3 (1.04)	2972.5	0.000**
Chair	2.8 (1.09)	3.1 (1.09)	3981.0	0.008**
Office Layout				
Desking arrangement	3.1 (1.06)	2.8 (1.05)	4131.5	0.028**
Layout	2.9 (0.82)	3 (0.87)	4977.0	0.782
Setting variety	3.1 (0.92)	3.2 (0.96)	4402.5	0.146
Stair access	2.7 (0.98)	2.5 (0.82)	1899.0	0.409
Kitchen/bathroom proximity	3.2 (0.53)	3.1 (0.61)	4780.0	0.417
Indoor Environmental Quality				
Indoor environment quality	2.7 (0.81)	3 (0.99)	4272.5	0.039**
Air quality	2.8 (0.72)	2.9 (0.93)	4691.0	0.301
Winter temperature	2.7 (0.75)	2.3 (0.87)	3918.0	0.004**
Summer temperature	2.7 (0.87)	2.6 (1.05)	4812.0	0.493
Access to daylight	3.1 (1.11)	3.3 (1.17)	4382.5	0.101
Office lighting	2.9 (0.93)	3.2 (0.9)	4135.0	0.021**
Acoustics	2.5 (0.91)	2.4 (0.97)	4828.0	0.520
Other Elements				
Choice of work location	3.5 (1.04)	3.8 (1.17)	4138.5	0.024**
Flexible hours	4 (1.18)	4.1 (1.02)	4929.5	0.814
Commute time	2.8 (1.13)	2.7 (1.22)	4606.5	0.323
End of trip facilities	4.7 (1.34)	4.5 (1.53)	4783.5	0.615
Gym	3.3 (1.17)	3 (1.04)	4335.0	0.066
Health incentives	3.3 (1.06)	3.1 (0.95)	4507.5	0.189

Note: Mean of a 1-5 scale where 1 is 'Significant negative impact' and 5 is 'Significant positive impact'.
***Statistically significant*

Comparison of before- and after-move for Cohort B

Perceived Impact on Health of Site C's workplace elements for Cohort B: For Cohort B, all elements increased or remained unchanged in Importance to Health from the before-move survey to the after-move survey (Table 7.17). For Cohort A, there was no statistically significant change when reporting the impact of the layout on health; while for Cohort B, the significant change (p = 0.049) was seen as positive, as before- and after-move means changed from 2.9 to 3.1.ETF was the only exception to this pattern, showing a slight decrease in importance. Two elements that were rated as more important to health at Site C reached statistical significance. These were Desk Location and Choice of Work Location.

Unlike Cohort A, who had not had stair access before the move, Cohort B – who had had stair access at Site B – increased their rating of importance of Stair Access from a mean of 4.4 to 4.6.

Table 7.17: Mean scores for elements' Importance to Health for Cohort B before and after-move

Cohort B Importance of Element	**Before Move Site B (n=186) Mean (SD)**	**After Move Site C (n=124) Mean (SD)**	**MWU**	***p*-value**
Individual Workpoint				
Desk	5.5 (1.46)	5.6 (1.39)	11071.5	0.621
Chair	5.8 (1.38)	5.8 (1.36)	11404.5	0.962
Office Layout				
Desk choice	3.7 (2.05)	4.3 (1.85)	9508.0	0.013**
Office density	5.6 (1.45)	5.8 (1.17)	10662.5	0.295
Openness	5 (1.57)	5.2 (1.42)	10555.5	0.290
Setting variety	4.6 (1.73)	4.9 (1.64)	9924.5	0.069
Stairs	4.4 (1.92)	4.6 (1.8)	10492.0	0.240
Indoor Environmental Quality				
Air quality	6 (1.25)	6.1 (1.14)	10706.0	0.371
Thermal comfort	6.1 (1.17)	6.3 (0.91)	10336.0	0.136
Daylight	6.1 (1.15)	6.1 (1.2)	11161.5	0.697
Office Lighting	6.1 (1.12)	6.2 (0.99)	10833.0	0.392
Acoustics	5.8 (1.41)	6.1 (1.04)	10495.5	0.273
Other elements				
Choice of work location	5.8 (1.48)	6.1 (1.32)	9782.5	0.032**
Flexible hours	5.9 (1.58)	6.1 (1.42)	10251.0	0.129
Commute time	5.9 (1.37)	5.9 (1.35)	11217.5	0.824
End of trip facilities	3.7 (2.34)	3.6 (2.22)	11086.5	0.697
Gym	3.5 (2.15)	3.7 (2.04)	10574.0	0.303
Health incentives	4.4 (1.91)	4.7 (1.88)	10118.0	0.081

Note: Mean of a 1-7 scale where 1 is 'Not important at all' and 7 is 'Highly important'
***Statistically significant*
Perceived Impact on Health of workplace elements- Cohort B at Site C

The table below presents a comparison for Cohort B of scores on the before- and after-move surveys for impact of workplace elements on health. Six elements were rated higher for their impact on health in the after-move survey than in the before-move survey, and these differences were statistically significant: Desk, Chair, IEQ, Choice of Work Location, Layout and Air Quality. The ability to choose work location was statistically significant in both Cohorts A and B for both Importance to Health and Impact on Health.

Table 7.18: Mean scores for elements' Impact on Health for Cohort B before and after-move

Cohort B Impact of Element	Before Move Site B (n=186) Mean (SD)	After Move Site C (n=124) Mean (SD)	MWU	*p*-value
Individual Workpoint				
Desk	2.3 (0.85)	3.3 (1.04)	5205.5	0.000**
Chair	2.4 (0.98)	3.1 (1.17)	7093.5	0.000**
Office Layout				
Desking arrangement	3.1 (1.06)	2.9 (1.05)	10207.0	0.147
Layout	2.9 (0.8)	3.1 (0.92)	9982.0	0.049**
Setting variety	3.1 (1.07)	3.3 (0.95)	10132.5	0.102
Stair access	3 (1.06)	2.7 (0.98)	877.5	0.243
Kitchen/bathroom proximity	3.1 (0.59)	3.2 (0.69)	10985.5	0.430
Indoor Environmental Quality				
Indoor environment quality	2.6 (0.91)	3.1 (1.14)	8582.5	0.000**
Air quality	2.7 (0.76)	3 (0.97)	8678.0	0.000**
Winter temperature	2.4 (0.86)	2.5 (0.99)	10745.5	0.650
Summer temperature	2.6 (0.89)	2.7 (0.98)	10477.5	0.338
Access to daylight	3.4 (1.12)	3.3 (0.97)	10264.5	0.202
Office lighting	3.1 (0.96)	3.1 (0.9)	10692.0	0.290
Acoustics	2.6 (0.88)	2.6 (0.86)	11311.0	0.858
Other elements				
Choice of work location	3.4 (1.2)	4.1 (1.05)	8020.5	0.000**
Flexible hours	3.9 (1.25)	4 (1.07)	10546.5	0.324
Commute time	2.6 (1.23)	2.6 (1.2)	11414.5	0.974
End of trip facilities	4.4 (1.34)	4.5 (1.44)	10967.5	0.663
Gym	3.4 (0.92)	3.3 (0.9)	10757.0	0.418
Health incentives	3.4 (0.97)	3.3 (0.86)	10413.5	0.182

Mean of a 1-5 scale where 1 is 'Significant negative impact' and 5 is 'Significant positive impact'.
***Statistically significant*

Responses for Cohorts A and B to their workplace environments have now been presented. The following section describes the workplace elements in further detail with some comparisons between the two Cohorts.

Individual workpoint (desk and chair)

The after-move workplace, Site C, was an ABW workplace whose desking was predominantly unassigned. Respondents could choose not only where to sit during the workday but whether to choose a HA desk or a fixed-height desk. Ratings by both Cohorts A and B of the impact of the desk on individual health increased from the before-move

survey to the after-move survey, and this change was statistically significant (**Error! Reference source not found.** and Table 7.18). Negative responses about the desks reduced considerably from 60.8% to 20.4%.

Site observations recorded the provision of new, highly-adjustable and supportive office chairs at Site C. The survey asked about training on how to use the desk and chair at the new workpoint in Site C. The highest frequency of training type was 'Group training', reported by 50.4% of the overall after-move cohort.

Office Layout

As observed during site visits and from the office layout diagrams before and after relocation, the layout of Site C was substantially different from the layouts of Site A and B. The survey asked respondents to indicate the presence of particular elements of office layout at Site C. A large proportion of responses (61.9% of Cohort A and 48.8% of Cohort B) indicated that the workplace was open-plan with no desk partitions.

There was a statistically significant difference for both Cohorts A and B when reporting on whether they moved desks during the workday; this is not surprising given that Site C was an ABW office with unassigned desks. At Site A, 97.5% of respondents 'never moved' desks and this changed for Cohort A when they were relocated to Site C, with over half moving every day and a smaller proportion moving 'some days' (Table 7.19). Cohort B reported higher mobility at Site C with 92.9% reporting they never moved at Site B but 87% reporting moving some days or every day at Site C.

Table 7.19 Movement between desks for Cohort A and B at Site C

Desk location movement	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*- value
Never move	20 (23.8)	16 (13.0)	14.042 (2)	0.001
Move some days	18 (21.4)	57 (46.3)		
Move every day	46 (54.8)	50 (40.7)		

There was also a significant increase in the preference for unassigned desking as measured before and after the move. Means increased from 9.1% to 29.8% (Cohort A) and 16.3% to 42.3% (Cohort B) (Appendix Table 9.45 Desk preference- Cohort B- before and after-move).

Indoor Environmental Quality (IEQ)

Perceived impact of IEQ (daylight, thermal comfort, and air quality, office lighting, acoustics) on health increased from before the move to after the move (**Error! Reference source not found.**, Table 7.18). Of all IEQ elements, the impact of Access to Daylight on health had the highest mean scores for before and after the move for both cohorts, but the

changes were not statistically significant. However, the impact of office lighting changed significantly from before to after the move for participants from Site A. When reporting acoustics and Impact on Health, there were no significant differences between the before and after responses, with relatively low mean scores.

Elements beyond the office

As a holistic perspective is taken in this research on the impact of the workplace on workers' health, the after-move survey collected data on elements outside the physical workplace design that impact peoples' health. These elements included flexible hours and choice of work location (Table 7.20). At Site C, most of the 224 respondents identified that flexible hours were available either as a company-wide policy (33.7%) or arranged within a department or team (46.6%).

Table 7.20 Flexibility options responses for Cohort A & B at Site C

Flexibility options	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Flexible hours options				
Company-wide	28 (33.3)	42 (34.1)	3.393 (3)	0.335
Department or team	38 (45.2)	59 (48.0)		
Set working hours	5 (6.0)	12 (9.8)		
Informal arrangement	13 (15.5)	10 (8.1)		
Choice of Work location				
None	20 (23.8)	19 (15.7)	2.123 (2)	0.346
Some	58 (69.0)	92 (76.0)		
Full	6 (7.1)	10 (8.3)		

Flexibility of hours and work location scored highly overall for both Impact on Health and Importance to Health. For example, mean scores above six (out of seven) were recorded for both cohorts at Site C on Flexibility of Location and Flexibility of Hours and Importance to Health. A significant difference was found for workplace flexibility's impact on, and importance to, health for both cohorts between the before- and after-move.

Survey responses suggested the organisation allowed greater flexibility in the after-move site than in the before-move site, as participants could choose their work location (from home, office or co-working space) at Site C. As shown in Table 7.20, at the after-move site, 72.5% (average of Cohort A and Cohort B) of respondents reported some locational flexibility (compared with 61.2% at before-move sites). Another 19.7% (average of Cohort A and Cohort B) reported that they had no choice as they were required to be in the office during business hours. The Impact on Health of this choice of work location was also statistically significant between before- and after-move sites. Those rating flexibility of work location as having a 'significant positive impact' on health increased from 27.4% to 43.5% with the move to Site C.

Commuting times increased for both cohorts at Site C with a significant difference for Cohort A. Site analysis showed that Site A had been close to a central transport interchange, potentially explaining the lowest average one-way commute time and the significant increase for Cohort A's commute to 50.7 mins when located at Site C. For Cohort B at Site C, commuting time increased by 3.2 minutes from the before-move Site B. As previously noted, in terms of Impact on Health, access to ETF rated the highest mean scores – above 4 (out of 5) for all cohorts and above all other elements.

Table 7.21 Commuting times for Cohort A & B before and after-move

Commute Time- Minutes	Before Move Mean (SD)	After Move Mean (SD)	MWU	*p*-value
Cohort A	(n=121)	(n=84)		
	41.5 (16.82)	50.7 (24.27)	3822.5	0.003**
Cohort B	(n=186)	(n=124)		
	48.8 (23.58)	52 (24.31)	10430.5	0.258

** *statistically significant*

Finally, there was a significant difference between the cohorts, before- and after-move, for Gym Access and Health Incentives (Appendix Table 9.32 Health facilities by Cohort- after-move). For Cohort A, Gym Access changed from 42.0% to 43.4% across the before- and after-move surveys; while for Cohort B, Gym Access significantly reduced on the move to Site C (72% to 52.8%, respectively). Presumably, this is explained by the fact that Site B included an onsite gym and a nearby gym while the after-move site did not.

Satisfaction responses at after-move sites

Observations at Site C found that the recent fitout had resulted in a higher quality indoor environment than at Sites A and B. This assessment was supported by the survey results and interviews that were generally more positive. Many before- and after-move changes were statistically significant in a positive direction. While 6.9% (average of Cohort A and Cohort B) of respondents were 'very satisfied' before the move, 22.5% (average of Cohort A and Cohort B) were 'very satisfied' after the move (Appendix Table 9.8 Satisfaction at Site A and Site B, Appendix Table 9.33 Satisfaction by Cohort- after-move). Furthermore, while the effect of IEQ on health impact was significantly different between before- and after-move sites for both cohorts, satisfaction only increased significantly for Cohort B (Table 7.22).

Table 7.22: Satisfaction with key elements before and after-move for combined cohorts A and B

	Satisfaction (mean of score on 5-point scale)			
Element of workplace	Before Move Mean (SD)	After Move Mean (SD)	MWU	*p*-value
Cohort A	(n=121)	(n=84)		
Furnishings- Desk and chair	3.1 (1.13)	3.1 (1.5)	4956.5	0.836
Layout	3 (1.07)	3.3 (1.35)	4514.5	0.161
IEQ	2.9 (1.01)	3.1 (1.24)	4490.5	0.141
Cohort B	(n=186)	(n=124)		
Furnishings- Desk and chair	3 (1.18)	3.5 (1.44)	8614.0	0.000**
Layout	3.1 (1.07)	3.5 (1.26)	8984.5	0.001**
IEQ	2.7 (0.97)	3.2 (1.24)	9126.0	0.002**

*** statistically significant*

Physical activity at the after-move site

Table 7.23 summarises the key elements that enabled physical activity throughout the workday in the office. The after-move workplace included many HA desks (70% of 790 desks), which would be expected to lead to increased standing time. Cohort B reported standing for an additional 67.3 minutes per day and reduced sitting by 13.9 minutes (Table 7.23). Despite access to a HA desk, Cohort A reported a decrease of 9.9 mins in standing time and an increase in sitting time of 69.8 mins per day. Reported work hours increased at the after-move site by 48 minutes over the week which may account for some of the increased sitting or standing time. There was no statistically significant difference between different age groups in changed standing or sitting times; under 30's group reported 40.8 hours per week and the over 50s group reported 38.5 hours per week.

Table 7.23: Comparison of physical activity before and after-move for Cohort A and Cohort B

	Before Move Mean (SD)	**After Move Mean (SD)**	**MWU**	***p*-value**
Cohort A	(n=121)	(n=84)		
Standing at desk - minutes	106.7 (100.87)	96.8 (141.71)	111.0	0.341
Sitting at desk - minutes	334.4 (174.44)	404.2 (92.43)	253.0	0.133
Stairs - use per day	0.5 (0.9)	1.6 (1.9)	114.0	0.061
Cohort B	(n=186)	(n=124)		
Standing at desk - minutes	60.6 (76.11)	127.9 (169.72)	452.5	0.327
Sitting at desk - minutes	428.4 (180.87)	414.5 (127.16)	1069.0	0.699
Stairs - use per day	1.2 (1.57)	2.3 (1.9)	2619.5	0.000**

*** statistically significant*

Site observations, interviews and floor plans showed that Site C included a large, open and accessible staircase between floors. There was a notable change in before- and after-move reporting of stair use with a three-fold increase for Cohort A and an almost two-fold increase for Cohort B for uses of the stairs per day (Table 7.23).

SF-12 results for Cohort A and Cohort B at after-move Site C

Table 7.24 presents results from the SF-12, both physical and mental health status, both before and after the move and self-reported sick days. Cohort A was slightly better than Cohort B both before and after-move locations. No statistically significant differences were found for either group after the relocation. However, the two cohorts are reported separately for consistency and comparison with previous separated Cohort A and Cohort B data.

Table 7.24: Comparison of before- and after-move SF-12 results and sick days for Cohorts A and B

	Before Move Mean (SD)	**After Move Mean (SD)**	**MWU**	***p*- value**
Cohort A	(n=121)	(n=84)		
SF12 Physical Composite Score	52.6 (6.58)	52.6 (7.51)	4449.0	0.964
SF12 Mental Composite Score	48.7 (10.09)	48.5 (10.02)	4323.0	0.707
Sick days	4.8 (2.64)	3.7 (2.31)	22.5	0.195
Cohort B	(n=186)	(n=124)		
SF12 Physical Composite Score	51.2 (8.05)	51.9 (7.71)	10121.0	0.471
SF12 Mental Composite Score	48.1 (10.57)	48.2 (10.42)	10565.0	0.911
Sick days	6.1 (8.7)	3.3 (1.68)	54.0	0.197

(Scores for before-move can be found in Table 7.12, p142)

Data was provided by Locomotion Ltd. on average sick days over the 12 months before the survey commenced. At Site A, absenteeism was 2.0 days per full-time employee per year, and at Site B, absenteeism was 1.96 days per full-time employee (excluding annual leave). However, self-report data from the survey indicated that sick days per year for Cohort A were 4.8 before-move and 3.7 after-move. For Cohort B, reported sick days were 6.1 before-move and 3.3 after-move (Table 7.24). The higher self-reported days (exceeding company records) may be explained by general discontent due to company restructuring and limited communication about changes in the workplace.

After-move cohort's SF-12 results were compared with community norm scores (Table 7.25). For the physical health score (PCS) ≥ 0.3 SD above the norm, Cohort A showed a slight decrease from 56.9% at Site A to 53.2% at Site C. Cohort B improved from 52.7% above the norm at Site A to 62.4% at Site C. For mental scores (MCS), approximately one-third of responses (Cohort A = 32.5%, Cohort B = 30.8%) were ≤ 0.3 SD below the norm and, similar to the before-move scores, more than 40% were ≥ 0.3 SD above the norm.

Table 7.25: SF-12 scores compared with community norm scores in the after-move cohorts

	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
SF-12 Physical Composite Score				
≤ 0.3SD below norm	10 (13.0%)	20 (17.1%)	4.333 (2)	0.115
Within 0.3SD of norm	26 (33.8%)	24 (20.5%)		
≥0.3SD above norm	41 (53.2%)	73 (62.4%)		
SF-12 Mental Composite Score				
≤ 0.3SD below norm	25 (32.5%)	36 (30.8%)	0.158 (2)	0.924
Within 0.3SD of norm	20 (26.0%)	29 (24.8%)		
≥0.3SD above norm	32 (41.6%)	52 (44.4%)		

While the use of SF-12 surveys in this study resulted in no statistically significant difference in reported health status between the before and after-move cohorts, there was a trend towards an increase in the physical health scores and a decrease in mental health score between the before and after-move environments.

Workplace elements and their relationship to health status

These results directly address two of the study's questions regarding which workplace elements impact health. Firstly, environmental elements that have been identified in previous studies to have an influence on, or association with, health status were examined. Key elements of the physical workplace such as Access to Stairs, ETF, Access to Gym and Layout Type were charted against mean physical (SF-12 PCS) and mental (SF-12 MCS) scores to identify their impact on health (Section Chapter 0). Secondly, workplace elements derived from the broader salutogenic view are explored in the same way. These workplace elements include Choice of Work Location, Flexibility of Work Hours and Desk Sharing (Section Chapter 0).

In addition, potential links between satisfaction with the workpoint, office layout, and IEQ were graphically assessed and reported in the following section. It is acknowledged that the workplace and associated factors are an ecosystem and difficult to individually isolate. However, the explorations reported in this section were undertaken to demonstrate the potential association of each variable in isolation. Chapter 6 forecast that an exploratory graphical approach would be undertaken if the data were unsuitable for other types of analysis such as correlation or regression. This was the case; and the data is presented graphically in the graphs in this section.

Environmental elements and SF-12 results

The results presented below include combined data from Cohorts A and B collected at the after-move location of Site C with the SF-12 PCS and MCS scores. The range for weighted SF-12 PCS scores was from 4 to 73 and the range for weighted SF-12 MCS scores was from 8 to 74. Higher scores indicate a better state of health. For the after-move cohort at Site C, overall PCS was 52.2 and overall MCS was 48.1.

Access to stairs

Figure 7.1 below shows that, in the after-move survey, respondents reporting 'No' to stair access had lower mean SF-12 MCS scores. Despite the presence of an open, easily accessible staircase, around one-third of Cohort B respondents (34.9%) indicated no stair access. These respondents also scored below the overall mean SF-12 PCS score (51.2) and overall mean MCS score (46.9). The PCS scores for those who reported access to stairs was in line with the overall mean PCS scores (52.2). Surprisingly, Cohort A respondents that reported no stair access had a higher mean PCS score of 53.5.

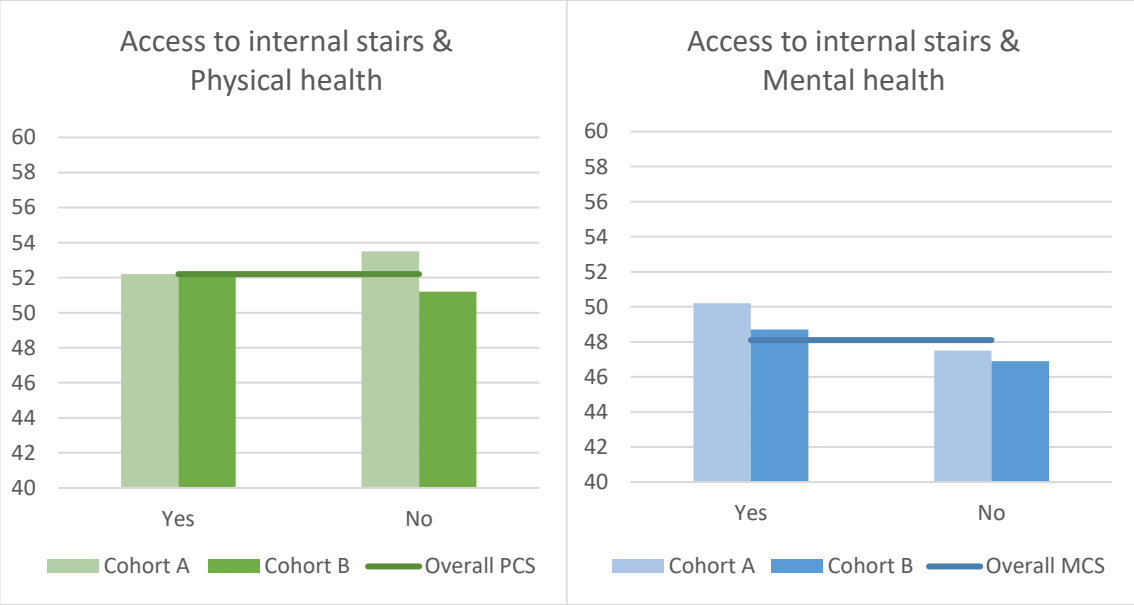

Figure 7.1 Access to internal stairs and health status for Cohort A and Cohort B at Site C

Access to End-of-trip Facilities (ETF)

Despite Access to ETF having the highest averages for both cohorts for Impact on Health, responses were mixed, with no apparent association between reported health status and ETF. (Figure 7.2). Those that used the ETF regularly scored above the overall mean MCS score of 48.1, with respondents from Cohort A who reported using ETF 'regularly' scoring the highest MCS mean of 52.2.

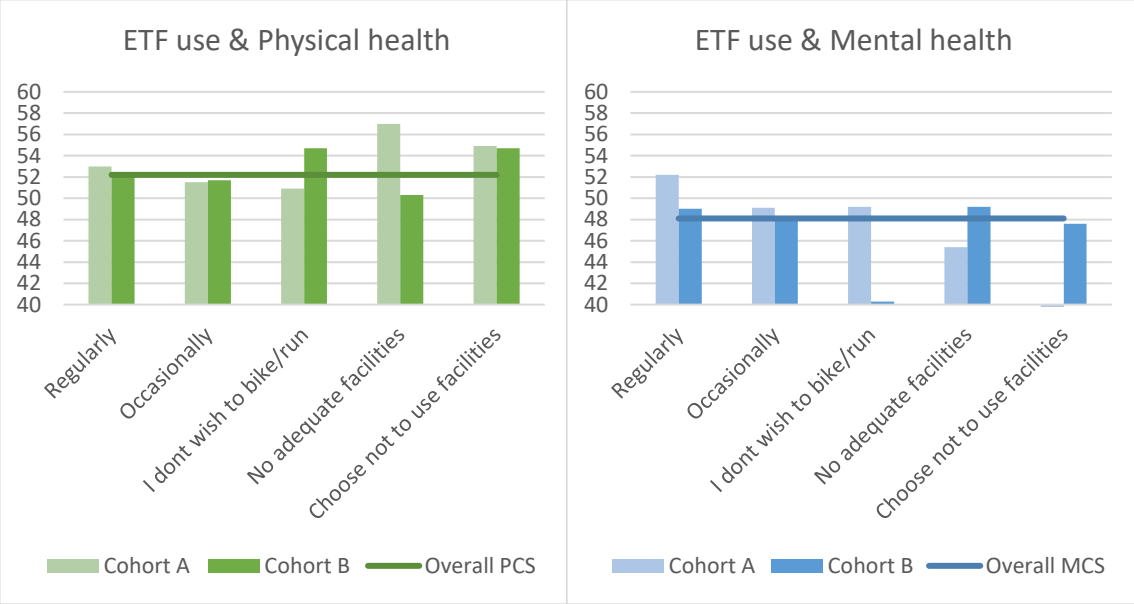

Figure 7.2: ETF and health status for Cohorts A and B at Site C

Office layout

Office layouts varied from those that included private offices to open-plan. Layouts may or may not have had partitions, and those that did may have had partitions of different heights (Appendix Table 9.35 Office settings- Cohort A-before and after-move Appendix Table 9.42 Office settings- Cohort B- before and after-move). For Cohort A, there was a significant difference in the layout type reported and mean scores for health impact before and after the move (Figure 7.3). Those in a shared private office (1.2%) reported the highest PCS score (56.5) which is higher than the overall mean PCS score of 52.2. The largest group (61.9%) that reported open-plan without partitions also reported a mean PCS score of 53.5 which is above the overall PCS mean, and reported a MCS score of 48.5, which was slightly above the overall mean MCS score. The second highest PCS score of 51.3 which was below the overall score, was for the group reporting open-plan with screens below 1.5 m (38.2%). For MCS scores, the group reporting open-plan with screens above 1.5 m (4.9%) scored an MCS of 51.9, which exceeded the overall mean MCS score of 48.1.

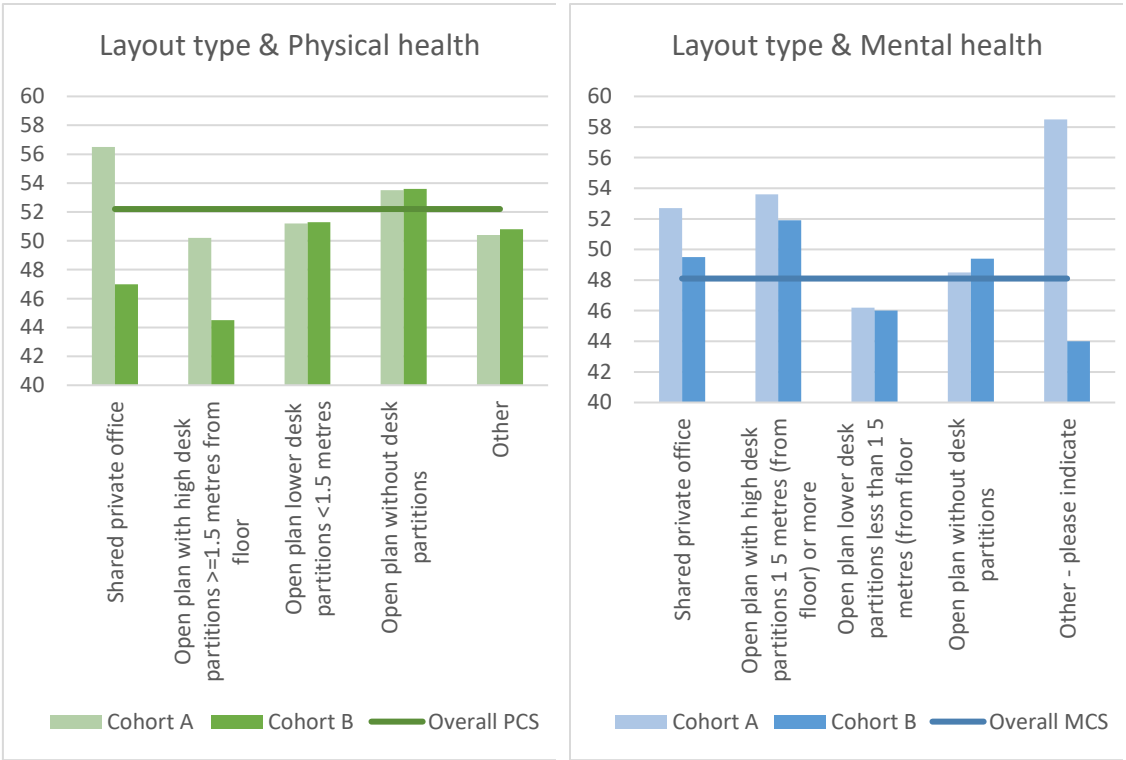

Figure 7.3 Office layout and health status after-move for Cohorts A and B at Site C

Key workplace elements and SF-12 results

A number of organisational policies and practices influence workers' experience of their workplace and, potentially, their health. Flexible work (hours and location) has been

identified in the literature as important to health or as having an impact on office workers health. The day-to-day experience of the workplace is influenced by organisational strategies including desk-sharing. In this section, links between key elements such as choice of work location, flexibility of hours and desk sharing and SF-12 PCS and MCS scores are explored.

Choice of work location

Choice of work location was the only element for both cohorts that had a statistically significant increase for both Importance to Health and Impact on Health between the before and after-move workplaces. As shown below in Figure 7.4, for those reporting full choice of work location, both cohorts' PCS scores (53.7 for Cohort A and 55.9 for Cohort B) were above the overall mean PCS score of 52.2. The highest PCS score (55.9) was from Cohort B group which reported full flexibility. Similarly, the highest MCS score was 52.3 for the Cohort A group, which reported full flexibility. Interestingly, Cohort A respondents reporting no choice of work location also reported a high PCS of 54.2 possibly suggesting that a defined 'all or nothing' policy could be more beneficial than a mix of both.

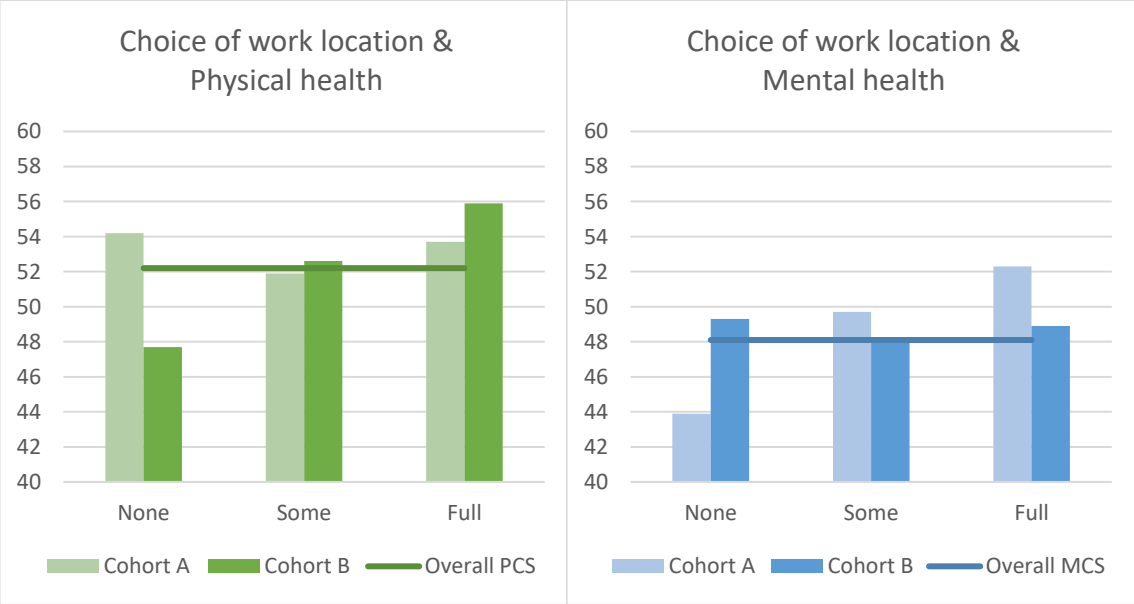

Figure 7.4: Choice of work location and health status at Site C

Flexibility of hours

Flexible hours rated highly in both cohorts for Importance to Health, with an increase in Impact on Health for both cohorts at the after-move site. Those reporting that flexible hours were managed within their team reported high PCS scores of 53.9 for Cohort A and 53.1 for Cohort B (Figure 7.5). Those reporting set hours had the highest overall PCS score of 54.8 for Cohort A and the lowest overall PCS score of 45.2 for Cohort B. This difference of response to set working hours suggests that while flexible hours may be beneficial to health for some workers, it can be negative for others.

Both cohorts that reported informal arrangements for flexible hours, scored below the overall mean MCS score of 48.1, with Cohort A scoring 40.9 and Cohort B scoring 45.9. On the other hand, those reporting an organisation-wide flexible hours policy, had the highest MCS scores, above the overall mean MCS scores, with Cohort A at 50.5 and Cohort B at 49.5.

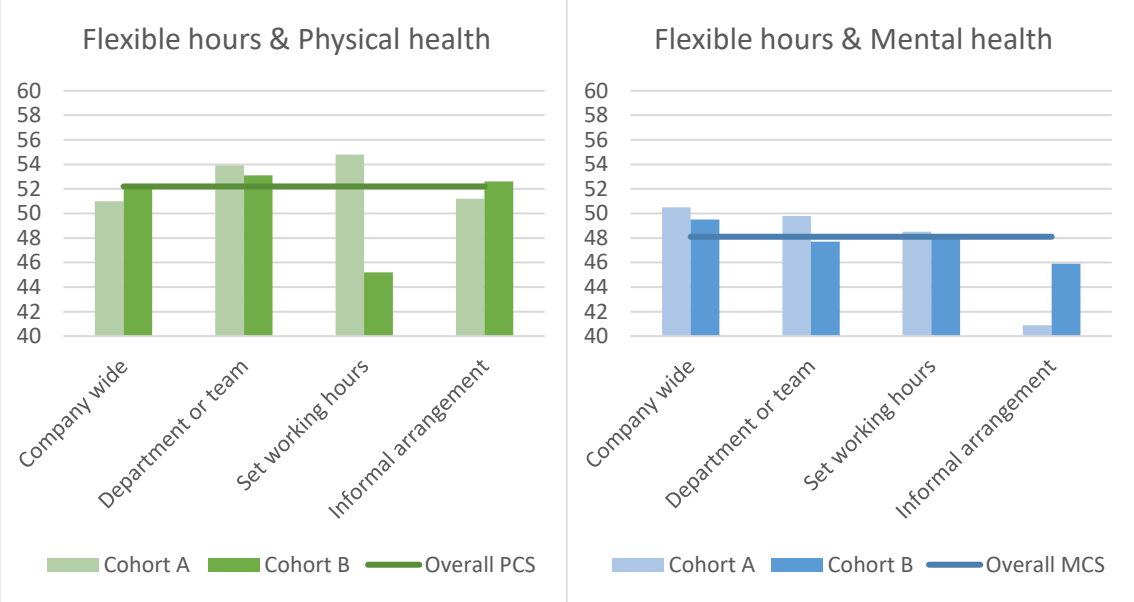

Figure 7.5: flexible working hours arrangements and health status for Cohorts A and B at Site C

Desk-sharing

As shown in Table 7.19 (see p149), 54.8% of Cohort A reported moving desks every day and 46.3% of Cohort B reporting moving some days. It is clear from the graph in Figure 7.6 that the lowest PCS scores were for those that never moved – Cohort A's PCS score was 50.1 and Cohort B's PCS score was 48, which are both well below the overall mean PCS score of 52.2. On the other hand, the highest PCS score of 54 for Cohort A and 53.5 for Cohort B were recorded for the subgroup that reported moving every day. The health benefits of desk sharing include the potential increase for incidental physical activity and ability to choose environmental conditions that are preferred. Both activities can result in reported improvements in perceived health and may explain the higher PCS scores recorded.

Results for the mental health scores and desk sharing are less clear. The lowest MCS score of 46.2 was recorded by the subgroup of Cohort A that moved every day, while the highest score of 49.4 was recorded by the subgroup of Cohort A that reported moving 'some days'. Cohort A also recorded the highest MCS score of 51.6 for those respondents who preferred to move about some days. The group that reported never moving desks scored above the mean MCS of 48.1, with Cohort A scoring 48.2 and Cohort B scoring 49.

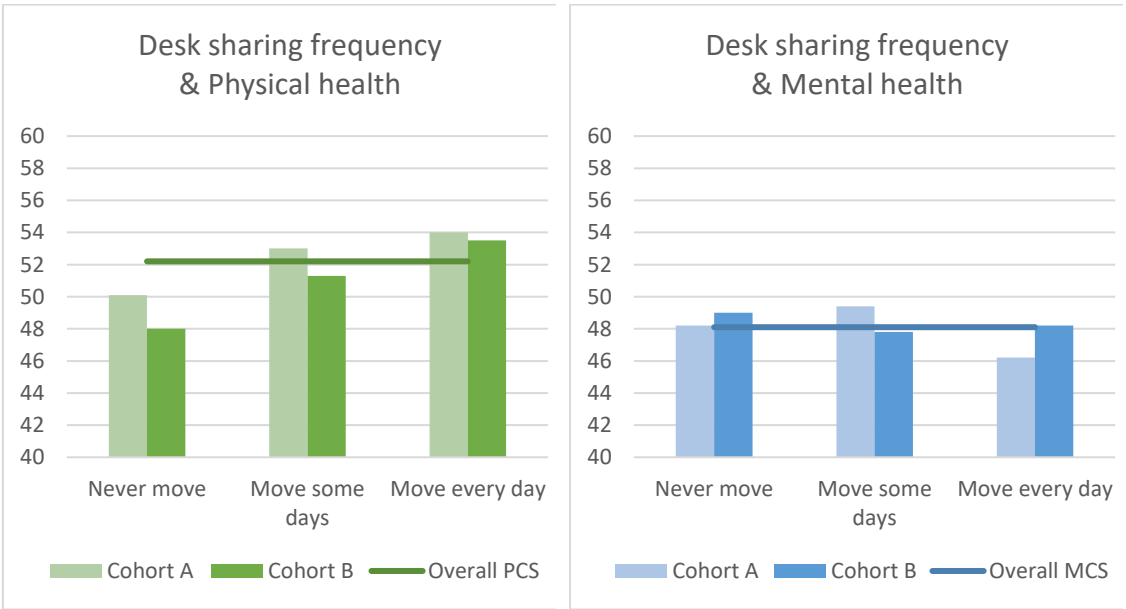

Figure 7.6: Desk sharing and health status at Site C

Satisfaction and health status

Graphical analysis was undertaken to identify any links between satisfaction and SF-12 results. Cohort B showed a statistically significant increased satisfaction at after-move Site

C for all three workplace elements: workpoint (desk and chair), office layout and IEQ, while Cohort A indicated less change with no significant differences (Table 7.22, page 152). The three elements analysed below – workpoint (desk and chair), office layout and IEQ – were chosen for graphical presentation because they are key elements in any office environment and survey results revealed differences.

Satisfaction with workpoint and health status

As seen in Figure 7.7 below, the highest PCS scores were from those who were 'very unsatisfied', while the lowest PCS scores were from those reporting that they were 'somewhat satisfied'. The highest overall PCS score of 54.8 was for the subgroup of Cohort A who were 'very unsatisfied', while the lowest overall PCS score was 47.6 from Cohort B. Those who were 'somewhat satisfied' or 'very satisfied' scored above the overall PCS mean score.

With respect to mental health scores, the highest mental health score of 49.6 was for the subgroup of Cohort B who were 'somewhat satisfied', and the lowest MCS score of 44.3 was for the subgroup of Cohort B who were 'somewhat unsatisfied'.

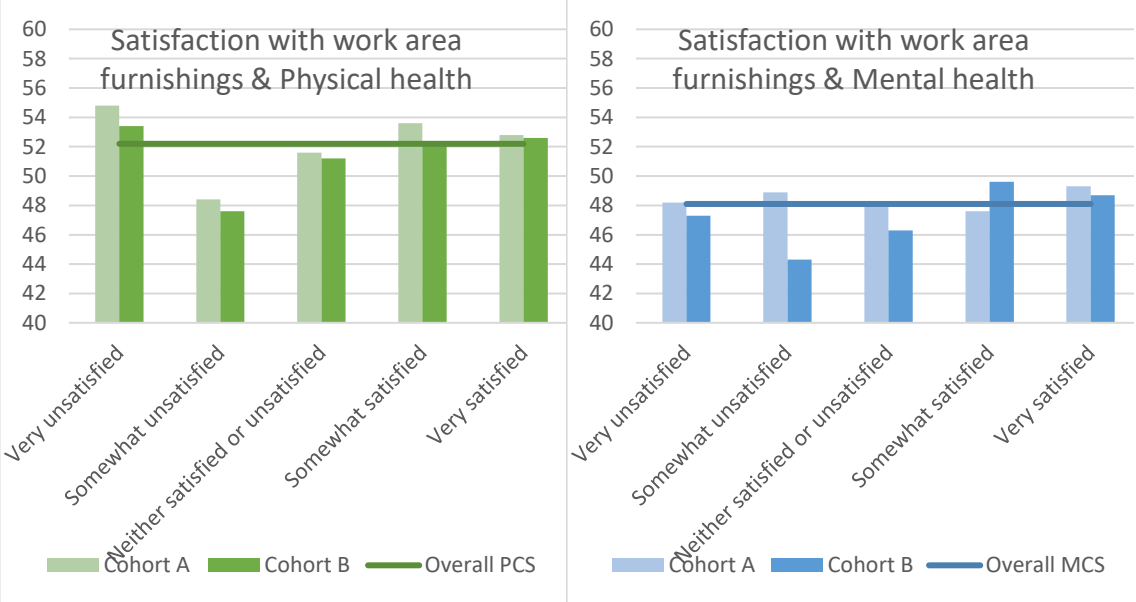

Figure 7.7 Satisfaction of workpoint and health status at Site C

Satisfaction with office layout and health status

When considering satisfaction with the office layout and health status, the lowest PCS score of 48.6 was for Cohort B respondents who were ‘very unsatisfied’, and the highest PCS score of 54.4 was for Cohort A respondents who was ‘very satisfied’. However, the second-highest PCS score of 54.1 was for Cohort A respondents who reported being ‘very unsatisfied’.

For the mental health scores, there was a tendency for MCS scores to increase as satisfaction levels increased. For example, the lowest MCS score of 43.7 was for Cohort B respondents who were ‘somewhat unsatisfied’, and the highest MCS score of 51.2 was for Cohort A respondents who were ‘very satisfied’.

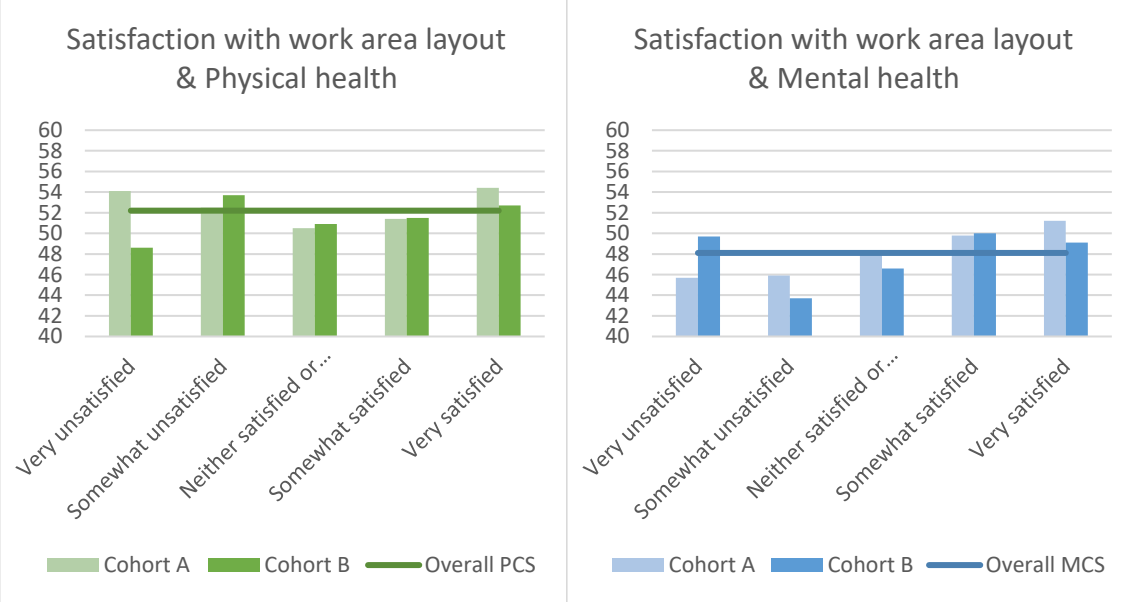

Figure 7.8 Satisfaction with office layout and health status for Cohorts A and B at Site C.

Satisfaction with IEQ and health status

Finally, the relationship between satisfaction with IEQ and health status are presented particularly in Figure 7.9. While mental health scores were relatively evenly distributed, there is less clarity with the physical health scores. For the PCS scores, the 'very unsatisfied' Cohort B respondents had the lowest PCS score (50), while the 'very unsatisfied' Cohort A respondents had the highest PCS score (53.7) (Figure 7.9). Overall, Cohort A had higher PCS scores than Cohort B. For the mental health scores, Cohort A respondents who were 'very unsatisfied' had the lowest MCS scores (38.1), and Cohort B who were 'very satisfied' had the highest MCS scores (51.1).

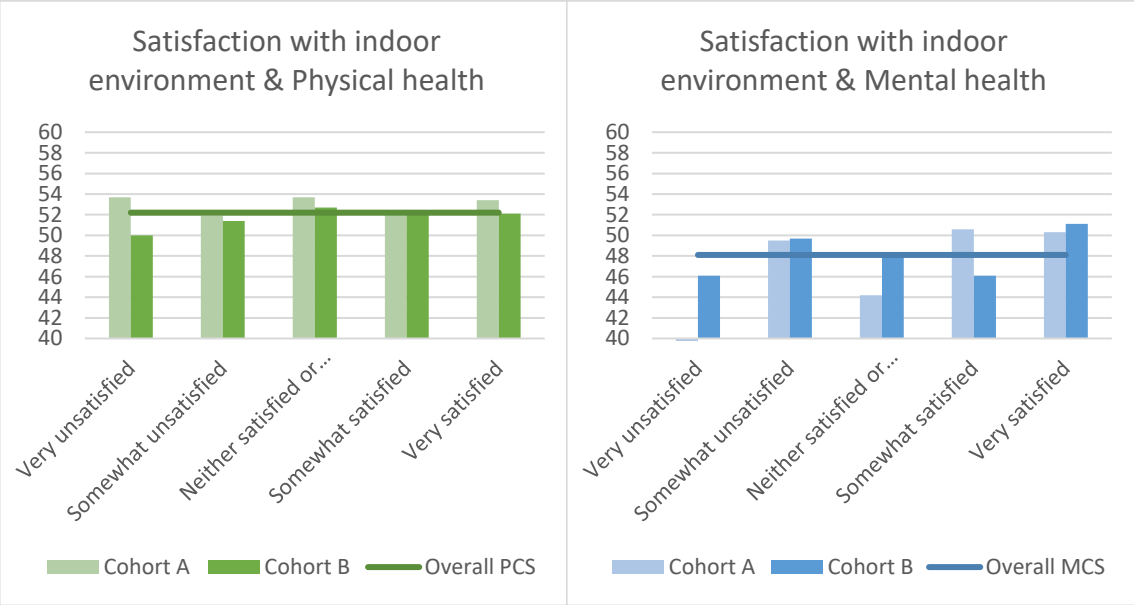

Figure 7.9 Satisfaction with IEQ and health status for Cohorts A and B at Site C

Summary

The results of this case study have been presented from two time perspectives using mixed-methods data collection at each stage. Chapter 6 'set the scene' by, based on site analyses, describing the three case study sites, Site A, Site B and Site C, and their attributes. Interviews focused on those involved in designing and managing these workplaces. Interview data, including descriptions of the design process, revealed that the organisation carried out their own informal research by visiting other workplaces and may have benefited from access to local benchmarked data or robust accessible data relevant to their objectives. It also revealed the limited amount of communication and health promotion completed due to reduced resources from company restructuring.

Following this, Chapter 7 presented the quantitative data obtained by surveying workers at all three sites before and after Cohorts A and B were relocated to a single workplace, Site C. Physical elements and workplace factors were found to impact office workers perceived health, as indicated by changes in responses between the before and after-move sites. Workplace elements that differed significantly for perceived Impact on Health between the before- and after-move surveys were the workpoint (chair and desk), layout, IEQ, air quality, lighting, and choice of work location.

While some physical workplace features, such as stair access, were seen by workers' to increase their physical activity, the same elements were not seen to have positive health impacts. Similarly, long sitting hours and long commuting hours were reported, but the impact of these on health was viewed as minimal or non-existent. These results suggest that respondents do not recognise the health benefits of various elements. The following chapter will discuss these results by themes that have surfaced throughout analysis. Later, these findings form the basis for recommendations that place office workers' health at the centre of office workplace design.

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Chapter 8 Discussion

This study investigated the relationship between workplace elements and office workers' perceived health status. The case study included three workplaces: Sites A and B were occupied before relocation to Site C, custom-designed for the organisation's needs.

Using a salutogenic lens, this research addressed the following research questions:

- Which environmental elements have the greatest effect on the perceived health status of office workers?
- What are the key factors to consider when creating healthy office workplaces?
- What are the key factors during the design process that limit the consideration of health-enhancing office environments?

Chapters 6 and 7 presented the analysis of the surveys and interviews from workplace A, B and C. As described in Methodology, in order to identify patterns or themes, all data sources were overlayed and reviewed concurrently and systematically. For example, site photos and site notes were cross referenced with interview transcripts to verify the data sources and identify any discrepancies for further analysis. Using a matrix by Creswell (2011) sources of data were merged to allow discovery of key findings. The synthesised findings of all the data collection phases have resulted in the emergence of meta-themes that have implications for workplace design.

These meta-themes are:

1. Enabling physical activity in the office workplace
2. Indoor environmental elements for a healthy office
3. Workplace flexibility
4. Health promotion in the office workplace
5. Evidence-based benchmarking for the design and evaluation of a healthy office

Each of these meta-themes will be addressed in turn in this chapter. In addition, although the case study was completed before COVID-19, implications for healthy workplaces in the post-COVID world are also discussed.

Attempting to enhance workers' productivity without enhancing workers' health is futile. Many of those involved in designing workplaces have sought to identify what can make a difference to office worker's health and how industry practices can be tailored to support health. Workplace practice tends to be siloed and lacks a holistic and salutogenic approach. This study is original in approach by investigating an ecosystem of many physical elements and associated factors within the workplace and how they specifically impact health status.

Salutogenic design for health-enhancing workplaces

In line with the WHO's holistic definition of health (World Health Organization 2002) and the proactive and health-promoting approach espoused by Ruohomäki, Lahtinen & Reijula (2015), this study took a salutogenic approach to workplace design, and included other workplace factors known to support well-being to improve health outcomes for office workers. Salutogenic design has been defined by Abdelaal & Soebarto (2019) as an enveloping framework that uses the built environment as a tool for health restoration and well-being. This health-enhancing environment and associated elements are also defined as 'any aspect of the physical environment (natural and man-made) that consciously or unconsciously relates to individuals and their health-enhancing physical activity behaviour' (Foster & Hillsdon 2004, p. 756).

While the role and expertise of interior designers and architects can be broad, the building occupying organisation itself needs to take the lead in ensuring that a multi-disciplinary team with varied expertise is involved in the design process. Professionals from disciplines beyond design could be health experts such as physiologists, occupational therapists, physiotherapists, ergonomists and other professionals such as HR and WHS. Designers predominately focus on designing the built environment based on a brief describing the client's requirements. Some designers may have specialist expertise in a particular type of environment; however, for health to be a priority, relevant health-related expertise should be part of a formal process. For the design of Site C, the overarching design brief was the inclusion of water (provision of accessible filtered drinking water), greenery (inclusion of indoor plants) and movement (opportunities to move about the office). Past project experience informed the interpretation and development of this brief.

The health-enhancing design intent was not fully realised due to two key factors beyond the designers' control. Firstly, a market downturn and organisational restructuring reduced the organisation's capacity to communicate with workers about the new workplace and provide ongoing health promotion. Secondly, the design team did not include a health expert which limited the focus on health and reduced the opportunity to integrate possible health promotion strategies. In addition, the conduct of a POE survey at Site C, such as BOSSA, to identify opportunities for ongoing improvements did not eventuate for reasons outside the control of the study. As the BOSSA data was only used as reference for background information, the lack of BOSSA data from Site C did not impact data analysis. Background information about the site and building was collected during interviews.

As revealed during KI interviews (KI1019), the involvement of the organisation's internal WHS professionals throughout the design process was limited. The organisations' HR and WHS professionals were involved only in the early stages of the design process. Their involvement was seen more as a corporate obligation by some key informants than as

harnessing the expertise of professionals who would add value to the workplace design. For future practice, the inclusion of a health promotion consultant or health professional could bring knowledge and experience that could directly affect the health outcomes of office workers. For example, knowing that cardiovascular disease is the leading cause of death in Australia (Australian Bureau of Statistics 2019), designed elements and organisational policies could enable healthy choices, including opportunities for incidental physical activity throughout the working day or promotion of active commuting (Cadilhac et al. 2011).

Supporting occupational safety was a strong feature of the organisation's culture, influencing the design process. While the health and well-being of employees were frequently mentioned as key drivers in the design of the after-move workplace, this study found that safety was the core organisational value. This approach of preventing health problems rather than enhancing health was also identified in the literature review by Colenberg, Jylhä & Arkesteijn (2020) as the predominant approach in 50 studies. The organisation's primary health-related concerns were compliance and risk reduction because of the industrial nature of the organisation's core business. For example, ergonomists were involved in selecting the task seating and ensuring that the chairs complied with Australian standards. The choice of chair met with the approval of workers obtained via a survey. Some respondents viewed this pathogenic or compliance-based approach – not uncommon in industry practice – as a constraint on the design process. There can be conflicting views on the selection of products and finishes during the office design process depending on the client requests and motivations of those selecting items. For example, while a specific office chair meets the Australian standard, the aesthetics and costs may not align with the designers' selection and the project budget. A balance must be found between designing for the well-being needs of office workers and compliance with safety standards (Anttonen & Rasanen 2008). The Finnish Institute of Occupational Health identified the need for inter-disciplinary cooperation in designing and implementing workplace projects. With this in mind, a six-year research program was undertaken, underpinned by a salutogenic framework (Anttonen & Rasanen 2008). The involvement of expert health professionals in change management and ongoing workplace management may be of significant commercial value to organisations, given the cost to employers of health-related lost productivity.

The five meta-themes identified through qualitative analysis of the interview data are now discussed for their role in a health-enhancing office environment. The quantitative analysis identified environmental elements that differentially affected perceived health between the before- and after-move workplaces. In addition, the interview data revealed unintended deficiencies in the design and implementation process, such as a lack of health promotion

programs for workers. Surprisingly, in the before- and after-move surveys, policy-based elements such as flexibility of work hours and location ranked relatively highly for Importance to Health. This discussion will inform recommendations for future healthy office workplaces, which are discussed further in Chapter 9. Recommendations include both physical elements of the indoor environment and organisational policies. The holistic approach taken in this study has identified the importance of health promotion and workplace flexibility for a health-enhancing office environment.

Meta-theme 1: Enabling physical activity in the office workplace

Increased physical activity throughout the day positively impacts health outcomes (Brown et al. 2011; Foster & Hillsdon 2004; McArthur & Powell 2020; Puig-Ribera et al. 2008; Sugiyama et al. 2020). This study has provided evidence that some workplace elements, such as accessible stairs, have a greater impact than others on creating opportunities for physical activity during the workday.

Stairs

Prominent stairs within the workplace encouraged office workers to move throughout their workday. The after-move survey results (Table 7.23 page 152) indicate an increase in reported stair use for both cohorts A (p = 0.061) and B (p <0.001) when relocated at Site C, concluding the subject organisation's aim to enable workers to move throughout their workday was achieved. However, respondents were unclear whether their access to stairs had changed from their before- to after-move site. Interestingly, almost three quarters of Cohort B (who had access to stairs at the before-move site B), acknowledged they had access to stairs at Site C. On the other hand, only a third of Cohort A (who had no prior access to stairs) reported having access to stairs at Site C. This suggests that prior exposure to stairs not only increased awareness of stair access but also improved usage. Despite these improvements in stair usage by Cohort A, this cohort scored below the overall SF-12 Physical score (PCS 46.9) and mental score of 51.2 (Table 7.24 p.153).

The staircase location within the floorplate at Site C may have influenced whether workers chose to use them. Site C stairs connected five tenancy levels and offered an alternative to lifts for movement between floors. However, the stairs were located at one end of the floorplate (Figure 6.9 p.125), which meant that many occupants would pass the lifts before reaching the stairs. In addition, workers did not need to move between floors to access the amenities, meeting rooms and social spaces as these were located on each floor. The need for face-to-face collaboration with particular colleagues was a key factor in whether workers used the stairs. In a study of an Australian workplace by Thomas (2010), the inclusion of prominent internal staircases in an office refurbishment was found to increase satisfaction, perceived productivity and health. Other research has also found that access to stairs improved physical activity (Hedge 2017; Jancey et al. 2016; Zimring et al. 2005).

These findings should encourage organisations to lease or design spaces that include prominent well-placed stairs.

Incorporating stairs into office spaces increases construction costs and leads to a potential loss of net lettable area (Zimring et al. 2005). A cost-benefit analysis of stair access showing the significant health benefits of stair access would provide designers or organisations with evidence to commercially justify stair inclusion. While a direct link between absenteeism and stair usage is difficult to establish, the cost savings in potential reduced absenteeism can be quantified against any additional stair costs. Some newer base buildings are designed so that the fire stairs can be used in preference to the elevators to move between floors. The fact that this design choice has been made suggests it is possible to achieve and may also be cost-effective. Examples include 100 Mount Street, North Sydney and 1 Bligh Street, Sydney (Dexus 2019).

At Site A, one fire stair was located near the main lifts (standard building design practice), and the other was centrally located to desks and meeting spaces (Figure 6.1 p.110). Despite the floorplate having two well-located fire stairs, there was no daily stair access for occupants due to security locking systems. The provision of stairs aligns with Centre for Active Design's (Centre for Active Design 2010b) recommendations. The Centre provides resources, such as checklists and guides, for increasing building occupants' physical activity throughout the office working day. For example, to encourage the use of stairs as the principal means of vertical transport, offices should include accessible stairs that are comfortable and safe to use.

The after-move site in the case study also conformed well with the Fitwel standard (Center for Active Design 2020) for its designed elements, including accessible open stairs, HA workstations and opportunity for workers to move about the office. The organisation's workplace brief was informed by visiting other premium workplaces globally. Many of these exemplars had implemented health-enhancing principles, such as the presence of water (access to filtered drinking water), greenery and movement. The inclusion of internal stairs as part of the floorplate required commitment by *Locomotion Ltd* as there were considerable additional costs for construction of the stairs and allocation of space (approximately 10% of net lettable area) that could otherwise have been used for business functions such as facilities and meeting rooms. In a study on the specific health benefits of using stairs, Rassia (2014) found that ascending at least 20 floors per week reduced stroke risk by 20%. Therefore, a focus on an office's staircase and circulation systems provides the best opportunity for increasing energy expenditure in the office workplace (Rassia (2014) Zimring et al. (2005).

The after-move workplace was designed to be an ABW workplace in which desks were unassigned, and a variety of settings were available to workers. Desk types were also changed to include more HA desks accessible for everyone.

ABW workplaces

The study findings that workers at Site C who 'never moved' from their desk reported lower SF-12 physical health scores than those that did move(Figure 7.6 p.161), further confirm the link between incidental physical activity and physical health (Owen et al. 2010; Thorp et al. 2014). The improvement in physical activity from introducing an ABW environment was also observed by Mackey, Engelen & Foley (2015), who found that as steps increased reported musculoskeletal discomfort decreased. Furthermore, Hedge (2017) found that breaking up sitting time and moving throughout the workday alleviated reported musculoskeletal complaints. Candido et al. (2018) and Kim et al. (2016) found increased physical activity resulting from 'non-territorial working' as workers were required to move about the office to different desks and settings. For example, if sitting for long durations is more common in the afternoons, standing meetings could be encouraged with table settings at standing height and communication about the benefits of reducing sitting time.

Both A and B cohorts in this case study reported the impact of desking arrangements on health to be less positive at the after-move ABW workplace than at the before-move workplace (**Error! Reference source not found.** p.146 and Table 7.18 p.148). It may be that respondents were unaware of the health benefits of increased mobility available in an ABW workplace. This is in line with opinions expressed in the interviews that the organisation had not adequately promoted the health benefits of moving to an ABW environment. Respondents may also have been unhappy with shared desking – and the loss of individual desks and fixed addresses at their previous workplace – for reasons independent of their health outcomes. Disruption and uncertainty resulting from organisational restructuring may also have contributed to a negative response.

Access to gym

Although workers had some gym access (on site or close by) at all before- and after-move sites, gym access was seen as having a 'neutral' health impact by two-thirds of respondents. This finding is consistent with Meister (2019) finding that fitness facilities were perceived as the least important workplace feature for health. IEQ elements such as air quality, comfortable lighting, comfortable temperatures and water quality ranked higher with 1,600 workers for elements that mattered to health (Meister 2019). Despite such findings, organisations frequently promote in-house gyms to potential employees, presumably because doing so effectively attracts staff. However, given that workers tend not to value gym access, it remains an open question whether providing gym access on site is necessary in the context of limited space and financial resources. Cohort B rated the

impact of gym access on health higher than Cohort A in the after-move workplace (**Error! Reference source not found.** p.146 and Table 7.18 p.148). This may be because, at their pre-move sites, Cohort B had access to an on-site gym while Cohort A had only off-site access.

Active commuting and ETF

The average one-way commute (including all modes of commuting) increased as a result of the move. In addition, return trip times ranged from 82 mins to 98 mins. These reported times are considerably longer than the average Brisbane commute time of 33.5 minutes each way (R 2017) and may have made active commuting impractical. Shannon et al. (2006) and Daley, Rissel & Lloyd (2007) suggest that distance of commuting, time constraints, and safety concerns impact the ability to actively commute. These factors were beyond the case study organisation's control. Active commuting has significant health benefits because it requires physical activity (Page & Nilsson 2017). In the study by Boyce et al. (2008), only workers who undertook vigorous exercise outside the workplace avoided weight gain; and, in a five-year study of over 1,000 workers, those that actively commuted to work were more likely to meet government physical activity guidelines (Blake, Zhou & Batt (2013). ETF is a critical enabler of active commuting and was consistently ranked the highest of all elements for Impact on Health by both cohorts, before and after the move.

Meta-theme 2: Indoor environmental elements for a healthy office

This study shows that workers perceived certain aspects of the physical workplace and organisational factors to affect their health, providing evidence to support designers and office workplace teams in implementing health-enhancing workplaces. The survey findings identified elements rated with higher positive impact in the after-move workplace than in the before-move workplaces (**Error! Reference source not found.** p.146 and Table 7.18 p.148) For both cohorts, these elements were the individual workstation (desk and chair). IEQ, and choice of work location within the workplace. The significant impact of some elements varied by cohort; for Cohort A, these elements were desking arrangements, temperature in winter, and office lighting, while for Cohort B, these elements were office layout and air quality. However, it is the combination of factors rather than individual elements that determine health and satisfaction (Bluyssen et al. (2011); Leaman & Bordass (2001). Two physical elements, the workstation (desk and chair) and IEQ will be discussed in detail below, while the policy-based choice of work location will be discussed subsequently.

Site analyses and KI interview responses found that indoor air quality and access to daylight were better in the after-move site than at the before-move sites. In addition, HA desking was available at the after-move site while it had not been available to most workers at the before-move sites. These workplace improvements were reflected in significant

positive changes in respondents' responses to these specific elements. For example, at Site C, Cohort B respondents' estimates of sitting time decreased and estimates of standing time increased (Table 7.23 page 152); this may be because of HA desking, as it enabled workers to choose whether and when to sit or stand. Other features of the after-move site may have contributed to improved IEQ. As mentioned by one interviewee, Site C had a recently installed air conditioning system with higher volumes of fresh air intake and better thermal control, which would be expected to improve thermal comfort and air quality. In addition, the implementation of ABW permitted access to daylight for all. The organisation planned to include these workplace features to improve the overall occupant experience and create a health-enhancing workplace.

The Workstation

Desk

A considerable part of the working day occurs at the desk and chair, making the desk and chair essential to consider when designing a health-enhancing workplace. HA desks, which allow individuals to sit or stand throughout their workday, were an integral inclusion in the design of Site C. Interview data revealed that the organisation had chosen to include HA desking to address one of their key drivers of 'movement' and to meet Green Star certification requirements. The substantial increase in HA desks at Site C may explain the longer self-reported standing time by Cohort B for Site C than for Site B (Table 7.23 page 152). This reported increase in standing time is consistent with the findings from other studies that provision of a HA desk does result in increased standing time (Alkhajah et al. 2012; Dutta, Walton & Pereira 2019; Grunseit et al. 2013; Healy et al. 2013; Neuhaus, Healy, et al. 2014). In addition, Site C respondents seemed to understand the health impact of HA desking, as their ratings of the desk's health impact before and after the move were statistically significant (**Error! Reference source not found.** page 146and Table 7.18 page 148).

It is likely that most, if not all, workers at the after-move site had access to a HA desk; while only 70% of desks were HA, the number of workers was lower than anticipated due to an organisational restructure. The ideal ratio of HA desks to fixed-height desks required to improve health outcomes has not yet been determined (Healy et al. 2013; Husemann et al. 2009; Karakolis & Callaghan 2014). Chair

Along with the desk, the office chair is a fundamental component of the individual work point. The new office chairs included in the after-move site were more supportive and had greater functionality than the chairs used at the before-move sites. The new chairs were Herman Miller Mirra 2, described by the manufacturer as providing 'support for seated movement' and allowing the 'body to move freely and naturally' (Herman Miller Inc 2020).

The seated movement that this chair permitted is consistent with the organisation's goal to increase their workers' movement throughout the workday.

Respondents' assessments of the impact of the office chair on their health increased for both cohorts from the before-move workplaces to the after-move workplace. Cohort B's rating of the chair's impact on health (Table 7.18 p. 148) and their satisfaction with their chair increased significantly from before to after the relocation (Table 7.22 p.152). These results suggest that workers recognised the contribution to their comfort provided by the new chairs. This is an example of the connection between satisfaction and reported health. Cohort A's increased rating of the task chair's importance to their health (Table 7.15 p.145) suggests an understanding of the chair's contribution to their health. While there was a formal process for selecting the desk and chair for Site C, one interviewee pointed out that workers had been given an opportunity to provide feedback on the chair samples. The inclusion of employees in the chair selection process is advocated by macro-ergonomics (Hedge 2017). In current design practice, allocating budgets and specifying particular elements is often independent of valuable evidence. The finding that respondents saw the chair as more important to their health than the desk (Table 7.15 p.145 and Table 7.17 p.147) can inform the budget decisions of organisations seeking to design a health-enhancing workplace. IEQ

The case study's after-move office interior environment was of better quality than that of the before-move sites. This was to be expected since the organisation sought to achieve Green Star credentials for Site C. Unsurprisingly, occupants showed greater satisfaction levels with overall IEQ. Similarly, the effect on the Importance to Health of the IEQ elements, air quality, thermal comfort, daylight, office lighting, and acoustics, increased from before to after the relocation. In addition, a positive relationship was found between reported satisfaction with IEQ and mental health status as measured by the SF-12 (Figure 7.9 p.164). Similarly, Herbig, Schneider & Nowak (2016) identified a link between office space satisfaction, environmental features and employee health, and regression modelling by Kim et al. (2016) found that a decline in occupant satisfaction predicted a negative impact on self-reported health. Likewise, Roulet et al. (2006) found a strong correlation between comfort and reported health-related symptoms. Other research (Agha-Hossein et al. 2013; Kim et al. 2016; Robertson, Huang & Larson 2016) has shown an association between reported satisfaction levels and reported health impacts: as satisfaction levels increased, negative responses about health decreased.

Access to daylight

Access to daylight is an environmental element in the workplace, often taken for granted until access is restricted. Workers' access to daylight in the office workspace is influenced by factors including the building's orientation, building and façade design, floorplate

dimensions and the workstation's location on the floorplate. At Site C, 90% of workstations were within six to seven metres of the façade windows, while at Sites A and B, it was 80% and 70%, respectively. Thus, access to daylight across the floor plate was better after relocation. Furthermore, as Site C had unassigned desking, workers were generally able to choose a position within the office space that met their preference for daylight. One interviewee recalled that many coworkers had commented favourably on the availability of natural light in the after-move workplace; they appreciated being able to move about to locate themselves to access additional light. In addition, both cohorts rated access to daylight the highest of all IEQ elements for health impact, before and after relocation with no significant change between before and after-move responses. The high value placed on natural light by the office workers in this study is consistent with the findings of a large survey of office workers (Meister (2019) in which daylight or 'comfortable light' was rated the second highest after air quality for impact on health and well-being. From a broader well-being perspective, Figueiro et al. (2017) and Boubekri et al. (2014) found that adequate circadian light during work hours improved sleep quality.

Air quality

Air quality was found in both the surveys and interviews to be a significant factor in health. For Cohort B, air quality was seen to positively impact health (Table 7.18 p.148), and for Cohort A, air quality was seen as important for health (Table 7.15 p.145). One interviewee appreciated the improved air quality at Site C, observing 'an increase in outside air rates through the air-conditioning … with more thermal control in meeting rooms' (KI 5). Nriagu (2011) quantified the relationship between air quality and health: by doubling the outdoor supply rate, illness and absenteeism could be reduced by 10%. In addition, Bluyssen et al. (2016) and Clements-Croome (2006) identified that clean air, with optimal ventilation rates for even distribution, is necessary for well-being. Furthermore, the review by Mujan et al. (2019) of 120 studies found that thermal comfort and indoor air quality were the primary factors impacting health, comfort and productivity in the office.

Thermal comfort

Some participants perceived thermal comfort to impact their health. Cohort A's reported thermal comfort in winter increased significantly with the move, and their reported thermal comfort in summer also increased, but to a lesser extent (**Error! Reference source not found.** p.146). Cohort B also reported an improvement in thermal comfort in both winter and summer. If temperatures are mechanically controlled within safe limits, a wworkplace's air temperature does not directly affect workers' health (Lan, Wargocki & Lian (2011). However, some participants in this study believed that it did: 'If [air temperature] is going up and down all the time, then people always naturally think, well, it's going from hot to cold, I'm going to get sick.' (KI 4 on Site A).

However, perceived health is linked to comfort (Kim & de Dear (2012); Leaman & Bordass (2001); Seppänen & Fisk (2006). While a subjective phenomenon, thermal comfort is influenced by an indoor environment's air temperature, air-speed, radiant temperature and humidity, in addition to clothing, activity level and personal factors. For these reasons, thermal comfort is often difficult to manage in the office workplace (Mujan et al. 2019). According to one interviewee, workers at Site A were frequently dissatisfied with the workplace's thermal control. The temperature variability may have resulted from high radiant temperatures at the façade areas and unwanted cold draughts from air conditioning diffusers.

Lighting

Lighting quality can significantly impact office workers' health and well-being (Boubekri et al. 2014; Mills, Tomkins & Schlangen 2007). The colour and brightness can impact the human circadian system which ultimately impacts wellbeing which is recognised by participants in this case study. Both cohorts rated office lighting of high importance to health in before and after- move offices (Table 7.15 p.145 and Table 7.17 p.147). For Cohort A, the relative high mean of 6 increased to 6.2 at Site C and Cohort B reported similar means of 6.1 increasing to 6.2 at Site C. The Impact to Health scores were both mid range from 2.9 and 3.2 for Cohort A to 3.1 for Cohort B (**Error! Reference source not found.** p.146 and Table 7.18 p.148).

Acoustics

The final IE element is acoustics within the office environment. At the before-move sites, both Cohorts recorded scores of 5.7 (A) and 5.8 (B) for acoustics and Importance to Health (Table 7.15 p.145 and Table 7.17 p.147). Later recognition of the importance of acoustics was noted with both Cohorts increasing in Importance scores to 6 (A) and 6.1 for Cohort B. Bergström, Miller & Horneij (2015) points out that open offices can result in increased noise levels and distractions for occupants which could be of concern for Locomotion Ltd. However, the adoption of ABW with a variety of settings allows individuals to choose spaces and move away from unwanted noise if needed. Colenberg, Jylhä & Arkesteijn (2020) acknowledges the complexity of measuring acoustics and their impact of health but confirms high levels of background noise can cause fatigue and annoyance. While interviews at Site A revealed concerns about noise, Impact on Health recorded a mean score of 2.5 which reduced to 2.4 at Site C. For Cohort B, there was no change to Impact to Health with a score of 2.6 (**Error! Reference source not found.** p.146 and Table 7.18 p.148).

Flexibility of work settings within the office

The final element of IEQ to be discussed is the extent to which workers could make day-by-day choices about where they worked within the office environment. Workplaces such as Site C that had adopted ABW practices enabled this flexibility.

Choosing a desk or setting within the workplace that satisfies workers' needs and preferences – and that is most suitable for the task at hand – enables workers to optimise their working conditions. The benefits of the ABW and flexible office environments have been considered in recent research (Meister (2019) Candido et al. (2018): individuals who enjoyed warmer, brighter spaces chose spaces near the façade while those who enjoyed cooler spaces did not. Seating locations can be varied throughout the day by occupants seeking their preferred temperature. This ability to partially 'control' the indoor environment is known to improve the satisfaction levels of occupants (Candido et al. 2018). Satisfaction levels and reported health status are linked; while the motivations to adopt ABW practice has traditionally focused on improving collaboration and space utilisation, the health benefits are now broadly accepted (Kim et al. 2016). With health at the forefront of decision-making in workplace design (Foster & Hillsdon 2004), organisations have the opportunity to make substantial and enduring positive changes that outstrip the benefits of saving space.

In considering Meta-theme 2 which focuses on the workplace's indoor environmental elements, the case study results are clear: high-quality office environments with health-enhancing elements such as a suitable workstation, good IEQ, and choice of work location within the workplace, improve health outcomes. While workplace factors such as ABW offer workers choice, the importance of well-designed settings and spaces are the foundation of a health-enhancing workplace. Workplace design including variety of types and styles of work settings offering choice for occupants should be a key principle. The results of this study are consistent with findings from the literature that health-enhancing characteristics include an indoor environment's thermal comfort, ventilation, natural light, minimal glare, low noise levels and spatial planning to suit various types of work (Bluyssen et al. 2011; Clements-Croome 2006). However, health benefits depend not only on environmental elements but on certain organisational factors that enhance the health benefits of these environmental elements.

Meta-theme 3: Workplace flexibility

A key feature of this study is the investigation of multi-faceted factors beyond the physical workplace that are essential to optimise health outcomes. While designers can optimise the interior physical environment, workplace policies that support the contribution of the interior environment are required if optimal health outcomes are to be fully realised. Hedge (2017) suggested that an explicit alignment between the physical workplace and associated

factors could improve workers' health outcomes. Ruohomäki, Lahtinen & Reijula (2015) recommended that further research be undertaken to determine how best to use theoretical knowledge to inform practice, and that a multi-professional approach is essential to achieve this.

Workplace policies on flexibility, which directly and indirectly impact health outcomes, were important to the case study cohort. The quantitative results of this study indicate that workplace flexibility (flexibility of work hours and work location) was rated higher in Importance to Health than the provision of ETF, gym access and health programs for all cohorts (Table 7.15 p.145 and Table 7.17 p.147). In this study, workplace flexibility was an organisational strategy with strong implications for workers' health. Choice of work location and work hours will be considered separately below.

Choice of work location beyond the office

Two-thirds of before-move respondents indicated that they had some flexibility in work location (other than the office), resulting in almost half reporting a positive impact on their health. In addition, when reviewing choice of work location and SF-12 health status results, those reporting full flexibility had the best physical health and those with no flexibility had the least (Figure 7.4 p.159). Interestingly, those reporting informal arrangements for flexibility recorded the lowest mental health scores on the SF-12 (Figure 7.5 p.160), potentially indicating that a lack of clarity or structure in workplace flexibility policies may be detrimental to mental health. This indicates that flexible working policies can be beneficial but that the development, implementation and communication of these policies are essential to achieving optimal health outcomes.

Choice of work location outside the office ranked in the top five most important elements in all cohorts; the only element where Impact on Health and Importance to Health reached statistical significance in both cohorts. Compared to the flexibility of hours, the change in choice of work location from the before-move to the after-move surveys was greater. Give the variability in responses, it would appear that many respondents were satisfied with working during set business hours but would nevertheless have preferred greater choice in work location, including working from home.

Flexibility of hours

Two-thirds of the before-move cohorts stated that flexible hours had a positive impact on their health. The large number of responses to the open question on flexible hours suggests that flexible hours was important to respondents In addition, flexible hours had the highest mean and frequency of importance rating for Cohort A and relatively high scores for Cohort B. Despite the importance placed on flexibility for health benefits, the literature suggests that a more tempered view is required (Hayman (2010) Nijp et al. (2016)

MacEachen, Polzer & Clarke (2008). While flexible hours has advantages such as better work-life balance, it also has disadvantages. Expectations by colleagues that a worker is available outside business hours was identified by Nijp et al. (2016) as a disadvantage of flexible work hours. Such blurring of the lines between work and home life affected perceived health.

Meta-theme 4: Health promotion in the office workplace

For a workplace to foster workers' health, health promotion experts should be engaged when designing and implementing a health-enhancing workplace (Trowbridge, Worden & Pyke 2016). Workers who moved into the newly-developed Site C were given limited information on using the new workplace features such as the internal stairs and HA desking. Key informants indicated that the lack of information was the result of the company's restructuring. Furthermore, many survey respondents were unaware of the health benefits of specific elements such as stair access, HA workstations and ABW. For example, the after-move workplace was designed using an ABW strategy that encouraged workers to move about during the workday. Most survey respondents indicated that they did not consider their health when choosing different settings within the office (Appendix Table 9.21 Health choices and flexibility- Site A and Site B , Appendix Table 9.47 Health choices- Cohort A and Cohort B- after-move). Similarly, the survey item, 'considering health when choosing settings', did not change significantly between before- and after-move sites.

Ergonomic training

Despite the lack of overall health promotion and communication about using the new office, training appears to have been provided for using the new office chair at Site C. This training may explain the positive change in reported health impacts for the chair. For Cohort B, sitting time was lowered in the after-move survey results, perhaps indicating that training had influenced workers behaviour in the new workplace. For Cohort A, sitting time at the after-move site increased (Table 7.23 p.152). The reason for this reported variance between cohorts is difficult to ascertain. Factors that may impact the effectiveness of the training such as type, timing and content was not provided by the organisation.

Training in the use of ergonomic chairs reduces musculoskeletal complaints (Robertson, Ciriello & Garabet (2013) Amick et al. (2012). For example, a training intervention consisting of an educational presentation and software prompts reduced prolonged sitting times and increased physical activity but did not reduce overall sitting time (Maylor et al. (2018). In a study by Amick et al. (2012), workers given a HA chair and ergonomic training in its use had significantly less eye strain over twelve months than workers given the HA chair and no training. Similarly, workers allocated HA desks plus training were less likely to sit for long periods than workers allocated HA desks without training (Healy et al. (2013). Furthermore, Hedge (2017) found that workers given HA chairs without training did not

necessarily sit in the chair correctly. Ergonomic training is fundamental to a macro-ergonomic approach and is required for workers to make optimal use of the workplace (Robertson et al. (2008). Training that enhances workers' ability to control their environment to meet individual needs leads to improved physical health and performance. For example, a macro-ergonomic study by (Robertson et al. 2008) found that introducing a flexible workspace plus ergonomic training was more effective than either alone for a range of outcomes, including ergonomic knowledge, environmental satisfaction, comfort and ability to control the environment for their specific needs.

This study has found that a combination of physical elements, supporting policy, ergonomic training and health promotion is required for ergonomic office equipment to be used effectively.

Communication

Workers did not receive sufficient information about using the ABW space at Site C to enable them to make the best use of the area. Key informants saw this lack of information as a failure of communication by the organisation. Effective communication is a key factor in preventing work-related musculoskeletal discomfort (Robertson et al. (2008). Health outcomes over the longer term are enhanced by good design and health-promoting policies and practices. Effective health promotion is embedded in organisational policies and supported by organisational culture (Chau et al. 2019; Goetzel & Ozminkowski 2008; Motalebi 2018; Punnett et al. 2009).

A salutogenic approach to health promotion is desirable as multiple factors influence health. To be effective, a health-positive workplace strategy needs to go beyond risk mitigation. Chau et al. (2019) explored attitudes to sitting and moving about in the workplace in 12 Australian organisations and concluded that health promotion practice focused predominantly on injury prevention and management. Despite this, Chau et al. (2019) also found that managers were aware that activity-promoting workplaces were beneficial for workers. Further engagement at various management levels is required to evaluate the importance of physical activity beyond risk mitigation.

The case study presented here found that workers were more likely to assess stair use as important to their health if they were aware of the benefits of stair use. Assessment by respondents of the impact of stair use on health slightly decreased from the before- to after-move sites (**Error! Reference source not found.** p.146 and Table 7.18 p.148), even though stair use increased (Table 7.23 p.152). Furthermore, despite Cohorts A and B having different levels of stair access in the before-move sites, their assessments of stair access's impact on their health at Site C did not differ. In addition, for Cohort A, stair access was the only element that declined in Importance to Health after the move. In

contrast, for Cohort B that had stair access before-move, stair access increased in Importance to Health on their move to Site C (Table 7.17 p.147); this may indicate that Cohort B's previous exposure to stairs sensitised them to the benefits of stair access at Site C.

A number of factors have been found to increase stair use, including stair use prompts, refurbishment of existing stairs and the communication of the benefits of stair use (Commissaris et al. (2016). These findings contrast with those of Engelen et al. (2017), which found no effect of direction and motivational signage intended to increase stair use.

Diversity and health-enhancing workplace factors

Age

In this research, age influenced assessments of the impact of various workplace elements on health. At *Locomotion Ltd*, most physical workplace elements, including access to gym and ETF, became less important to health with age except for Access to Stairs. The younger before-move cohort viewed flexible work hours and the length of the commute as the most important influences on health, and this trended downwards with age.

Gender

Gender also influenced the assessed effect of certain workplace elements on health. Given the roughly equal split between the genders in the working population, it may not be possible to 'please all of the people, all of the time' when designing health-positive workplaces. For example, thermal comfort, access to daylight and lighting were more important to females than males. Meeting the needs of both men and women in this context is mitigated in an ABW workplace in which workers can move around to find conditions they find comfortable (Foley et al. 2016; Kim et al. 2016).

These findings suggest that employee demographics should be analysed in the early stages of the design process to inform a workplace design that is as inclusive as possible.

Meta-theme 5: Evidence-based benchmarking for the design and evaluation of a healthy office

The organisation that was the focus of this case study had not collected health-relevant data about their workplaces. This is not unusual by industry standards. If collected using industry-standard tools such as BOSSA, the organisation could use such data to compare its workplaces to industry norms. This study has identified factors that limit – and promote – access to evidence obtained in the workplace, necessary to inform the design and operational decisions to improve office workers' health.

The case study organisation's use of evidence

Using benchmarked industry metrics on health in the built environment is an essential step in the process of designing a health-enhancing workplace (Trowbridge, Worden & Pyke (2016). *Locomotion Ltd* was committed to the collection of some data relating to the occupant experience. The BOSSA survey tool was used for Sites A and B, but the survey was not conducted at Site C due to organisational constraints and change in priorities at the time.

In setting up Site C, the organisation based design decisions, which potentially affected workers' health, on the previous experience of the organisation and design team. Using this approach meant that the principles used to make design decisions were not necessarily informed by the latest research and evidence on design for health-enhancing workplaces. There were also informal efforts by the in-house team, before working with the external design consultants, to obtain information relevant to health-enhancing office design which included visiting exemplar projects overseas to identify practices for incorporation into the local design process. The full value of the knowledge gained in this way could not be effectively transferred to the project team because it was not systematically recorded or later verified by comparing it with the existing evidence base. Without formal recording of information gained from the overseas fact-finding missions, the information passed on to the design team may have been subject to recall bias. This may have been the case since, in the words of one informant (KI 10), the transfer of information to the design team was 'a little bit blinkered or limited'. Nevertheless, some elements within the design and implementation of Site C, such as HA desking, have been previously established as effective in improving workplace outcomes.

A structured approach to collecting the necessary data is needed to effectively inform the design process (Chamberlain (2018). Kroemer (2017) went further, stating that a scientific approach is necessary to achieve environments that meet the specific ergonomic needs of the occupants. As part of a structured approach, data obtained by subjective means should be objectively validated wherever possible. Two examples can be provided from this case study to illustrate the value of objective validation. First, respondents' reports of the number of sick days were substantially different from the objective data on absenteeism provided by the organisation. This has implications for the validity of the survey finding that absenteeism fell after relocation. Second, obtaining objective data to verify self-reported sitting time, standing time and stair usage may have strengthened this study's findings.

While the subjective methods used in this research have been tested for validity and found to be robust (Hanc, McAndrew & Ucci 2019; Lindert et al. 2015), there is nevertheless value in using objective measurement devices to confirm the accuracy of self-reporting (van

Nassau et al. 2015). Knowledge translation for the design of health-enhancing workplaces can be optimised using formal and objective data collection methods.

Access to evidence for industry professionals

Quality evidence to support good workplace design is limited and often inaccessible to designers. While peer-reviewed research on various individual elements exists, it is not often accessible and is unfamiliar to practitioners. The value of academic literature and its' availability to those outside universities is sometimes not recognised and content can be difficult to decipher for some. Evidence for the effectiveness of many elements of the indoor office environment, such as desks, chairs and layout, is not based on high-quality, independent research. Instead, designers frequently rely on product suppliers who have a commercial interest in the inclusion of the products. For example, literature on the benefits of standing desks is produced by workstation manufacturers. In contrast, the evidence base for certain environmental elements such as air and thermal control is much stronger. Australian standards specify requirements based on robust calculations and modelling, and engineers design products to meet these specifications. The installation is then certified by regulated certification consultants.

For designers wishing to avail themselves of evidence-based information to design high-quality workplaces, the process for doing so is unclear. No peer-reviewed research was located during the literature review for this study on the way designers obtain information to inform their design practice. The evidence that does exist is difficult to interpret since, in the absence of industry-agreed standardised measures, a wide range of measures have been used by researchers (Torbeyns et al. (2014). Standardisation of measures and analytic methods for office interiors would immeasurably improve the evidence base (Aristizabal et al. (2019). Designers can contribute to the evidence base by using standardised procedures for collecting and using workplace data.

The situation is even more acute in the area of designing for healthy workplaces. Evidence to support best practice and protocols for designing health-enhancing workplaces is necessary but largely absent. While obtaining the data necessary to contribute to the evidence base is possible, it does not often happen. The POE tool, BOSSA, for example, is generally used only when a project is seeking accreditation from a ratings system such as Green Star or NABERS. The problem of uneven access to evidence-based information is compounded by the difficulty experienced by some industry practitioners in interpreting and extrapolating from relevant peer-reviewed research on health-enhancing workplace design. Better quality data on healthy workplace design is needed.

Healthy workplaces in the COVID era

The COVID-19 pandemic has affected how and where office knowledge-based work is conducted, highlighting the importance of a flexible salutogenic approach to health-enhancing workplaces. In this section on healthy workplaces in the COVID era, the health effects of COVID and possible ameliorating strategies are considered through the lens of the findings of this study. Many of the findings about fostering health in the workplace shed light on how health can be enhanced through home-based working.

An important determinant of perceived health in this study was the Choice of work location. As a result of the COVID-19 pandemic, many organisations, of necessity, have provided their workers with a significant and unexpected degree of workplace flexibility, with many requiring staff to work entirely from home (Arlington 2020; Choudhury 2020; Johnson 2020). The COVID-19 pandemic has forced organisations and their workers to quickly adapt to a highly flexible workplace (KPMG 2020), with all that entails for productivity and staff well-being.

Health and working from home

Social distancing requirements and fear of COVID-19 have resulted in many office workers working from home (Johnson 2020). A March 2020 survey of 800 global HR executives found that 88% of companies required or encouraged their employees to work from home (Arlington 2020). Many office workers have enjoyed working from home. In a survey of 3,000 respondents, (Lister & Kamouri 2020) found that 77% of respondents were satisfied with the new workplace flexibility. Working from home has substantial impacts – both positive and negative – on workers, including potential injuries from an inadequate workspace set-up, reduced physical activity and social isolation.

The health effects of working from home

Working from home is likely to have health and productivity consequences (Ekpanyaskul & Padungtod 2021). The sheer numbers of workers globally working from home due to COVID-19 suggest that any adverse health impacts of home working will be a significant global health issue (Bouziri et al. (2020). This underscores the importance of correct ergonomic practice and support for home-based workers by their employers to mitigate potential negative health effects. While working from home can increase productivity (Rothe 2020) and reduce travel time, overall time spent working increases ((Davis 2020; Johnson 2020), influencing work-life balance. While much media attention has been given to the potential health effects of working from home, research lags behind. The global Leesman Index 2020 has captured a wide range of data from 144,581 home-based workers from March to September 2020 (Leesman Index 2020). This dataset of home workers enables benchmarking and comparison with office workers' responses (Oldman 2020). The Index's focus on employee engagement and experience means that identifying the health impacts

of home-working from this dataset is difficult. Furthermore, as publicly available data is aggregated, it does not have sufficient granularity to identify specific health impacts at an individual level.

Health impacts of home-working include the ergonomics of the home office set-up, physical activity and mental health consequences (Ekpanyaskul & Padungtod 2021). From an ergonomic perspective, ensuring access at home to suitable IT equipment, furniture, lighting, and other environmental and ergonomic factors is challenging; and, if not adequately addressed, could lead to adverse health outcomes (Bouziri et al. 2020).

During the COVID-19 epidemic, rates of physical activity have reduced dramatically (Tison et al. 2020). As physical activity is central to maintaining health and avoiding disease (Lee et al. 2012), this reduction has health implications. A large survey of CSIRO's *Total Well-being Diet* online community found that 66% of respondents reported less physical activity during the pandemic (CSIRO 2020). For the broader population, reduction in physical activity and reduced daily step count is confirmed by the Tison et al. (2020) analysis of step counting data of 455,404 users from 187 countries. Results highlight a 27.3% reduction in daily steps taken 30 days after the pandemic was declared, with variations between countries depending on the extent of disease and government-enforced lockdowns (Tison et al. 2020). Moderate physical activity was reduced by 74.6% due to COVID-19 in a study that compared 2019 pre-pandemic data in Thailand with data collected in 2020 (Katewongsa et al. 2020). Office workers generally engage in incidental exercise throughout their workday by, for example, attending meetings and participating in social activities. Such incidental exercise is less likely when working from home. Working from home saves time in commuting, allowing more time for recreational activities, but it is unclear how individuals choose to use this 'free' time.

Mental health issues have increased during COVID-19 (Johnson 2020); many people feel overwhelmed and overworked. Blurring the line between work and home life has inherent pitfalls; health may be impacted because working from home can reduce social contact causing social isolation, a risk factor for many health conditions (Meister 2020; Öste 2020). Remote working means that some employees need to balance their caring responsibilities in their homes, disproportionally affecting women (McPhail 2020; Meister 2020).

Organisational strategies for health-enhancing home-working

Working from home requires employers to manage workers remotely to prevent loss of productivity and maintain workers' well-being. Clear policies should set out expectations for employees and employers (Geisler 2020; Öste 2020). The health risks posed by poor ergonomic setup (Bouziri et al. 2020) in the home concerns employers, as they have their legal and moral responsibilities to their remotely-working employees (KPMG 2020). Some

large global organisations, such as Google, provide allowances to establish sound ergonomic practices in the home environment (Beasley 2020).

Providing programs that encourage good work practices at home is essential to support workers' health and well-being (Arlington 2020; Öste 2020). Organisations can address some of the health risks of remote working through health promotion and education. This is particularly important when it is impossible to establish an adequate ergonomic setup and work tasks encroach on home life. For example, taking intermittent breaks is more important if the worker does not have a HA desk at home or does not have ergonomic seating. Healthy practices such as local walking during breaks may replace walking around the office. Health promotion strategies centred on replacing commuting time with physical activity could further enhance health outcomes for remote workers. Health promotion can effectively extend beyond the office workplace by providing information to workers about activities known to increase energy expenditure, such as stair climbing. Workers can be encouraged to use stairs at home and in the local community. When employees attend the office, health promotion can focus on activities undertaken in whichever location work is taking place, whether the office, the home or elsewhere (Geisler 2020; Shain & Kramer 2004a).

Health in a post-COVID office environment

Industry predicts that post-COVID, working from home will continue to at least some extent (Luca et al. 2020). It could be inferred from this that office indoor environmental elements will be less important as contributors to health (Rasheed, Khoshbakht & Baird 2021). However, this notion assumes that the home working environment is healthy with an ergonomic setup suitable for long periods of sitting and screen-based work.

Summary

This research shows that a health-enhancing workplace consists of specific design elements of the office workplace (workpoint, IEQ and access to daylight) integrated with health promotion and flexible workplace policies. Taken together, these physical design elements and organisational practices will optimise workers' health outcomes. This research has implications for future practice, which will be detailed in the following chapter alongside some final recommendations.

An injury prevention or risk mitigation approach to design and management of the workplace, given the increasing awareness of the workplace's impact on health, is no longer adequate. As presented, a salutogenic approach – which is inherently holistic and positive – provides a framework to address the shortcomings of the current approach to workplace design and health. The framework promotes physical activity in the workplace by

incorporating specific design elements and health education. Organisational policies such as flexible work arrangements must align with physical design elements.

The involvement of multi-disciplinary teams in all phases of health-enhancing workplace design and implementation will not only support occupant health but promote it (Ruohomäki, Lahtinen & Reijula 2015). Finally, a universal tool or system that measures, analyses and benchmarks workplace health will help build an evidence base that will be of value to those implementing office workplaces in the future.

Limitations of this study

The inter-relationships between building users, the organisation, and the broader environment affect the experience of office users. Some aspects of the external built environment were beyond the scope of this study. For example, the location or siting of buildings that accommodate office workplaces and the proximity to local amenities significantly affect the physical activity of occupants (Zimring et al. 2005). It is also acknowledged that the office ecosystem also encompasses the social and cultural factors that can have significant impacts on employees

The survey design included keeping the survey as short as possible to ensure high completion rates. This may have reduced opportunities to make more definitive conclusions. Further, reducing the number of questions may have compromised the final analysis. Some terms such as ABW may have been interpreted differently by respondents.

Finally, the organisation was restructuring when participants moved to Site C, and some positions were made redundant. As a consequence, a substantial number of workers left the organisation. Details of the changed organisational structure were not available for inclusion in this research. These organisational changes may have impacted survey responses. Staff may have had less time to participate in the study in the after-move period, which may have impacted some responses.

BOSSA site data was available for before-move Sites A and B but not for after-move Site C due to reduced resources. While some useful building metrics would have been obtained from a BOSSA report for Site C, it was possible to source similar information from the organisation or other industry-available data such as real estate reports. This lack of Site C BOSSA data limited the opportunity to compare it with Sites A and B BOSSA data.

Chapter 9 Recommendations and Conclusion

As Australia is a world leader in progressive workplace design (Risch & A 2019) by adopting the recommendations below, our workplaces can become not only effective spaces for business but healthy environments for people. The need to address the health of office workers has become more pressing as more of the global workforce move to desk-based office employment. The design and implementation of workplaces must address the health of those who use them. This is of benefit to not only workers but their organisations who will benefit from health-related improvements in productivity and efficiency.

An injury prevention or risk mitigation approach to design and management of the workplace, given the increasing awareness of the workplace's impact on health, is no longer adequate. As presented, a salutogenic approach – which is inherently holistic and positive – provides a framework to address the shortcomings of the current approach to workplace design and health. The framework promotes physical activity in the workplace by incorporating specific design elements and health education. Organisational policies such as flexible work arrangements must align with physical design elements.

The involvement of multi-disciplinary teams in all phases of health-enhancing workplace design and implementation will not only support occupant health but promote it (Ruohomäki, Lahtinen & Reijula 2015). Finally, a universal tool or system that measures, analyses and benchmarks workplace health will help build an evidence base that will be of value to those implementing office workplaces in the future.

In this chapter, six key recommendations are made, based on this study's research findings, that, if implemented, will enhance designed workplace features to maximise workers' health:

1. **Recommendation 1: Adopt a collaborative and inter-disciplinary approach** that brings together experts from health, WHS, design, architecture and facilities management.
2. **Recommendation 2: Design to encourage physical activity in the workplace** to counteract the predominately sedentary nature of office work.
3. **Recommendation 3: Promote health in the workplace.** Health promotion and education are essential to ensure employees know the value and benefits of designed elements for health outcomes.
4. **Recommendation 4: Incorporate elements into the office that have the greatest impact on health,** such as access to daylight for all.

5. **Recommendation 5: Incorporate aligned organisational workplace policies,** such as flexibility, as integral to future workplace design implementation.
6. **Recommendation 6: Measure and benchmark the health status of office workers.** Accessible evidence is required to inform designers to create environments that are proven to be supportive of individuals' health. A robust and standardised industry tool for health assessment is essential to improve outcomes.

A framework for health-enhancing workplace design

The principles of good design for health-enhancing workplaces will be most beneficial when incorporated into an overarching framework developed collaboratively by a multi-professional workplace design team. This framework, based on a salutogenic approach, should go beyond current practice. Much research on workplace health focuses on individual workplace elements. Yet, influences on health are multifactorial, making it difficult to generate evidence-based holistic strategies that link interconnected environmental features and their impact on occupants' health. In addition, socio-demographic factors affect the workplace experience, so interventions should take this into account (Punnett et al. 2009). An integrative framework will align physical workplace elements and organisational policies and ensure their benefits are consistently communicated and implemented. Further, it will overcome siloing that is currently a feature of workplace design practice by integrating health expertise and evidence.

Responses to the COVID-19 pandemic confirm the need for a salutogenic approach to workplace design and operations. Interior designers can no longer work independently of workplace policy-makers and those managing employee needs. Workplace policies must be sufficiently adaptable to ensure employees' health and safety wherever they work (Meister 2020). Research and practice of the design and operations of the office workplace will need to keep abreast of expected changes to work hours, work patterns and work location (Ekpanyaskul & Padungtod 2021).

Recommendations

Recommendation 1: Adopt a collaborative and inter-disciplinary approach

Organisations wishing to implement a health-enhancing workplace need to adopt a collaborative and inter-disciplinary approach to workplace design and implementation. The client's intentions to achieve a health-enhancing workplace must be established and maintained throughout an integrated design process to ensure these strategic elements remain part of the final built project (Church et al. (2011). Expertise is required in the fields of health, WHS, design, architecture and facilities management. The key elements of healthy workplace design need to be fully integrated with workplace policies and health

promotion generated by a range of experts or relevant professionals. For example, the safety of remote working depends on the promotion of safe work practices, including best-practice ergonomic setup. Another example is the need for evidence-based design and decision-making. The collection of data to inform this evidence base requires a universal, easy-to-use health workplace measurement tool that can be used to generate accessible benchmarked data. In this case study, if workers received education from health professionals about the health benefits of stair use, their stair use may have increased.

As organisations understand the value of healthy workers, engaging workplace teams with relevant health experts is essential. The advent of health-focused certification tools such as the WELL Building Standard (International WELL Building Institute 2018) and Fitwel Standard (Centre for Active Design 2010a) may also contribute to this necessary change.

Recommendation 2: Design to encourage physical activity in the workplace

As the working population increasingly undertakes sedentary indoor employment, indoor environments must incorporate elements that enable and encourage physical activity throughout the workday. Physical elements that increase physical activity in the workplace, such as HA desking and accessible stairs, should be incorporated into office design. In this study, HA desking increased standing time. The inclusion of accessible stairs in the workplace was the most effective way to increase energy expenditure and reduce sitting time for the workers in this study. As stair climbing expends more energy than HA desking, increasing stair usage would be a more effective intervention to increase physical activity than HA desking. In addition, workplace strategies such as ABW and workplace flexibility provide opportunities for physical activity during the working day. Health promotion is also an opportunity to increase physical activity during the workday. Strategies could include communication to encourage breaks from sitting and comprehensive programs to ensure ergonomic principles are support and adopted in the office and at any remote working location. These case study findings support introducing organisational strategies to increase intermittent standing or moving by workers. However, further observational research is required to understand workers' actual activity times and patterns to identify behaviours that can be more effectively managed for further health improvements (Chambers, Robertson & Baker 2019; Foster & Hillsdon 2004).

Movement about the workplace is unlikely to be sufficient to meet the government recommendation of 150 to 300 minutes of moderate physical activity or 75 to 150 minutes of vigorous-intensity physical activity per week (Australian Government Department of Health 2021). The workplace can also promote opportunities for higher intensity activity beyond incidental movement around the office. Interior and exterior spaces that enable higher intensity physical activity would be beneficial. If this is not possible, policies that encourage active commuting, such as adequate ETF facilities, could be implemented.

Access to ETF was rated relatively high in this study for its impact on health, particularly for the under-30s age group. This shows strong support for active outdoor activity.

Recommendation 3: Promote health in the workplace

Health promotion and health programs are often independent of any workplace design, which runs the risk that such efforts do not align with the physical designed environment – and in some cases, work against it. In order to leverage the full potential of the workplace's physical environment, aligned and integrated health promotion needs to be designed and implemented concurrently. While design can enable health-enhancing choices, there is a need for integrated health promotion as part of workplace design and operations. The Ottawa Charter for Health Promotion (World Health Organization 1986) envisages a health-promoting workplace framework that fosters workers' control over their lives to improve their health.

For health promotion programs to be effective, cooperation between the various stakeholders is required (Shain & Kramer 2004a). This is consistent with the participatory ergonomics approach, which holds that interventions are more effective if users are involved in their design (Punnett et al. (2009) Hedge (2017)). Effective health promotion strategies must include HR policies that actively incorporate health promotion, integration with WHS and leaders who encourage active participation and ownership of health. For example, an organisation that wishes to invest in their employees' health has many options, among which are building gym facilities and developing an education program to promote breaking up sitting time. Building a gym will cost substantially more than the education program, yet it will benefit far fewer employees. Further investigation is required to identify the optimal settings, location, promotion methods and specific facilities to improve gym usage and reported health outcomes.

Inadequate communication with workers about the potential health benefits of design elements reduces the health potential of that design element. This study found that a lack of communication with workers at Site C about the benefits of stair use resulted in the under-use of the stairs, and the full health benefits of stair use were not realised.

Employees are more likely to adopt and effectively engage with health-enhancing features of the workplace if they have been actively involved in creating them; this applies both to the design of the physical elements and policy. In this study, limited employee engagement in the development of the ABW workplace strategy seems to have contributed to the negative responses to the ABW desking arrangements. Conversely, the inclusion in trials of some employees for selecting desks and chairs was well-received. Organisations wishing to optimise their workers' health could adopt a participatory approach to workplace health, implementing specific health and ergonomic programs adapted for the particular occupants.

For example, employees could participate in workshops and decisions relating to elements such as ETF, individual workpoints and elements known to have significant health impacts, such as stair access.

Specific workplace guidelines could be created by an organisation for its workers that include guidance on targets for standing time, taking active breaks from sitting, and other lifestyle advice such as nutrition and stopping smoking (Buckley et al. (2015). Buckley et al. (2015) acknowledge the need for further longer-term intervention studies to understand how rising chronic diseases can be mitigated in the workplace.

As with any effective strategy implementation, health promotion programs need to be evaluated to determine if they achieve their intended effect and determine how they can be improved.

Recommendation 4: Incorporate elements into the office that have the greatest impact on health

Three workplace features have been found to have the greatest impact on workers' health: the individual workpoint, access to daylight and ability to choose the location of work within the office space. These elements can be prioritised to maximise the workplace's positive impact on health. Funds could be differentially allocated based on the value to workers' health of specific design elements. In addition, given the importance of air quality to health and productivity, assessment of air conditioning and ventilation should be a priority during the site selection and design processes.The individual workpoint (desk and chair) is a high impact element for workers' health. For many office workers, a considerable part of the day is spent sitting at an individual desk and chair. HA desking and the task chair provides the user with a choice of posture and movement with health benefits such as reduced musculoskeletal complaints. Further research could include large-scale observational studies with or without objective measuring devices to track workers' patterns of use of HA workstations, providing evidence for designers when selecting desking types in the future (Chambers, Robertson & Baker 2019)As shown in this study, the chair was rated of greater importance to health than the desk. Selection, specification and budget allocation should respond accordingly. In addition, user engagement in the selection process is also of value to ensure individual feedback is incorporated.

Workers' access to daylight is a key feature of a health-enhancing workplace. Ideally, daylight penetration should be to the centre of the office so that all workers have reasonable access to natural light. Maximum daylight penetration of the office space is best achieved when the floorplate is the appropriate size for daylight to reach the centre. However, a smaller floorplate is inconsistent with the demand for larger floorplates that support the collaboration and visibility of teams. Ideally, the initial selection of an office site

will be influenced by the site's access to natural light. In an already established workplace, the design of the workplace can be optimised to maximise daylight penetration. For example, if the base building floorplate or façade limits daylight, social and collaborative spaces should be situated along the façade to ensure access for all occupants. Without adequate daylight for office workers, it is unlikely that interior design can compensate for this essential element for improved health and satisfaction.

Workers' ability to choose the location of work within the workplace is the third factor that can be prioritised for workers' health. Such flexibility will enable workers to choose spaces and settings that support their unique ergonomic and environmental preferences. ABW settings allow workers to make this choice. Locational flexibility in the workplace maximises the number of workers who can access the spaces closer to the façade for improved daylight access. This is an appropriate and egalitarian solution to address this need. Workers will make the best use of a flexible workplace if given information about why and how to use it. In the case study, workers at Site C were not provided with this information, which resulted in the underutilisation of the various spaces. Another effect of the lack of education on the use of space was negativity towards ABW as a way of working.

In an ABW office context, workers can benefit from flexibility, while the organisation can benefit from efficient space utilisation. The policy decision to implement such flexibility may be the most cost-effective way to prioritise health if changes to the physical workplace are not possible.

Recommendation 5: Incorporate aligned organisational workplace policies

Two policies emerged as being significant for health: ABW and workplace flexibility. Workplace flexibility was highly valued by all respondents – above all other elements in this research. Working at locations outside the office, such as the home, can improve workers' health and well-being. Flexible workplace policies can reduce commuting times and free up time for non-work activities. The design and development of these policies must be aligned with the physical workplace environment, and this requires a collaborative approach between professionals involved in these decisions. As discussed, a key benefit to ABW environments is the choice provided to occupants to adjust the setting to suit their functional needs and their environmental preferences. This exercise of choice provides higher levels of satisfaction and health.

To accommodate a diverse workforce, spaces and policies need to be flexible from the outset. If the aim is to improve or promote workers' well-being, understanding the dynamic interplay between these factors is required (Stokols (1992). For example, two-thirds of case study participants were aged between 31 and 50 years, so the design and promotion of workplace policies should be specifically responsive to the needs of this age group.

However, workers aged 50 years and over and workers aged under 30 years and under each accounted for over 20% of the case study sample. These groups should also be considered by design and policy that is sufficiently flexible to accommodate them.

This research has found that the ways in which both design and organisational policies are developed, executed and communicated determine their ultimate success. For example, introducing workplace flexibility required a company-wide policy that was clearly understood by all. In the case study, flexibility that was arranged informally had a negative impact on mental health. Findings from previous research on the health outcomes of flexible workplace policies have been mixed, further confirming the need for clear, well-communicated, and well-managed policies. Potential adverse outcomes of workplace flexibility, such as blurring of the lines between work and home life, can be managed effectively with clear policies that are supported by management. In addition, health promotion programs can ameliorate the lack of hands-on ergonomic support in remote settings.

ABW and workplace flexibility are policies likely to be particularly important post-pandemic. A flexible policy response will be needed as office space requirements fluctuate as workers dividing their time between the office and home.

Recommendation 6: Measure and benchmark the health status of office workers

There is a need for measurement and assessment tools for workplace and occupant health that use universal, standardised data collection methods. The development of guidelines for healthy workplace design requires more high-quality research on the specific elements that impact physical activity and, thereby, health (Foster & Hillsdon (2004). Further, industry standards for healthy workplace design need to be developed. The availability to designers of industry benchmarks may hold the key to improved health outcomes for workers.

Much can be learned from the green building industry in the quality of its policy, measurement, systems, and benchmarking. Health-focused resources for built environment industry professionals are the first step in creating integrated public health tools similar to existing environmental sustainability practices. While the WELL Building standard is comprehensive and focuses predominately on health and the built environment, assessment under the standard requires a significant financial and resource investment out of the reach of many organisations. A rating and benchmarking system for health-enhancing workplaces could be based on a familiar framework such as the green building certification system. The Fitwel system, modified for this purpose, may also be suitable and accessible.

The built environment industry would benefit from methods to assess individual elements of the total environment for increasing physical activity throughout the working day. In

addition, workers' health status should be measured using a standardised health-specific tool such as SF-12. Data from office workers should be collected and available for comparison. Universal and accessible tools to generate benchmarked health-related data would be of significant value to those involved in designing and developing the built environment. Due to the commercial nature of existing POE surveys and rating tools, detailed data is not generally accessible to industry professionals. Information sharing that is reciprocal between those in practice, such as designers, workplace consultants and researchers, would require developing a universal tool or platform that allows data to be consistently collected, aggregated, and publicly available.

Barriers to using objective diagnostic tools for measuring workplace health have been identified: they can be expensive, cumbersome and not ideal for field studies as some environmental measuring devices are large and heavy and can interfere with daily operations. Technological advances are helping to overcome some of these barriers. For example, mobile diagnostic tools, such as heart rate monitors, are becoming increasingly affordable and smaller; such trends are likely to continue. In the future, research into the effect of the workplace on workers' health will use objective measures to validate self-reports.

A barrier to using objective health measuring devices is – and is likely to remain – workers' willingness to permit their employer to collect their personal data. Many employees do not want their employer to access their health biometric and activity data. The balance between the need for objective data and privacy infringement is difficult to achieve.

As a final recommendation on measurement, close monitoring of remote working is necessary to understand the changing needs of employees and ensure that workers are not only satisfied but safe and that their well-being is catered for (Geisler 2020; KPMG 2020).

Conclusion

Designing health-enhancing workplaces is critical in improving public health outcomes, and greater engagement with evidence will strengthen design practice. A salutogenic design approach offers a solid theoretical framework for contemporary health promotion and practice. It provides enough flexibility to satisfy the unique requirements of all organisations and their employees. Three research questions were posed at the beginning of the study, and each will be considered below to see how the findings answer them.

The first research question was, *Which environmental elements have the greatest effect on the perceived health status of office workers?* Three elements in the office ecosystem had

the most impact on perceived health: chair, desk and the overall IEQ. A HA desk allowed for different postures with a supported comfortable chair when completing individual tasks while access to daylight is critical to good health. Workers responded positively to a high-quality indoor environment that enhanced satisfaction and perceived health.

Unique to this study is the discovery that health promotion enhanced the benefits of these three physical elements, supporting a holistic, salutogenic workplace health model. Health promotion, including ergonomic training on the use of designed elements, leverages the positive impact of a health-focused workplace design. While previous research has focused on individual workplace elements, this research examined the interconnections between physical and policy-based elements that made up the health-enhancing workplace ecosystem.

The second research question was: *What are the key factors to consider when creating healthy office workplaces?* A multidisciplinary or multi-professional approach to workplace design that includes the expertise of health professionals will result in optimal outcomes for office workers' health. A broad salutogenic framework should inform this multidisciplinary approach. Choice of work location was consistently reported as a significant impact on health status. This workplace element of flexibility confirms that all physical and policy-based elements need to be coherently designed as one healthy workplace to respond to the individual needs and preferences of employees. In addition, including health promotion will maximise the potential benefits of designed elements. ABW should also be considered if health is a priority, as it encourages movement throughout the day and allows individuals to choose the most supportive environment for their work and health needs.

Unique to this study is the use of the standardised health tool, SF-12, in this context, as it allowed exploration of the relative impact of elements on health status. For example, those reporting high workplace flexibility had higher physical health scores than those reporting no flexibility.

The third research question was, *What are the key factors during the design process that limit the consideration of health-enhancing office environments?* Certain practices that aimed to prioritise occupant health fell short of delivering the best health-enhancing solutions. For example, organisation staff conducted a global tour of best practice workplaces, but the findings were not formally recorded or benchmarked against industry data. Documenting best practice should use a standardised tool so that workplaces can be designed that enhance health outcomes. A multidisciplinary approach is required throughout a project's design, implementation, and operational phases to ensure health is at the forefront of decision-making. This diverse multi-professional team must be led, supported and financed by the organisation undertaking the development of the new

workplace. While interior designers play a pivotal role in the design of workplaces, the inclusion of other experts will further enhance proposed design concepts.

Unique to this study is investigating broader elements beyond the physical office, such as flexibility policies and ABW strategies that are all part of the workplace ecosystem that impact workers' health. Workplace design and implementation require an encompassing salutogenic approach to consider all elements that positively impact health.

This research, presented from a salutogenic perspective, makes a unique and valuable contribution to a future workplace design and implementation approach. It clearly illustrates that workplace design needs to extend beyond the physical environment and encompass policies to achieve the best possible health outcomes for occupants. The case study workplace included many physical elements such as stairs, HA desking and access to daylight for an optimal health-enhancing environment. Furthermore, if policy and health promotion are aligned and given equal consideration, this office could be leading the way as a health-enhancing workplace.

This research provides an opportunity to reset current design practice affecting office workers' health and well-being. A salutogenic design framework reframes the built environment and aligned health promotive policies as the foundation for office workplace health and well-being.

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Appendices

Appendix A Before-move survey

[redacted]our health in the office. June 2018

Introduction

1. I have read the above information and agree to participate in the survey *

- I agree
- I do not agree

2. Which office address do you currently work at?

- [redacted]
- [redacted]et

Section 1.1: Individual desk/workstation and chair setup

3. I would like to link your answers to this survey to another survey in future, but want to do this in a way that protects your privacy. Could you please write a number or word that is easy for you to remember but one that doesn't identify you, such as the last 4 digits of your mobile number. I will ask you to give this number or word at the beginning of the second survey, so we can match your answers to the two surveys.

4. In general, how satisfied you are with your work area's furnishings such as the desk and chair

- ○ Very unsatisfied
- ○ Somewhat unsatisfied
- ○ Neither satisfied or unsatisfied
- ○ Somewhat satisfied
- ○ Very satisfied

5. What type of desk or workstation do you have?

- ○ Fixed/ not adjustable/ seated only
- ○ Height adjustable allowing me to sit or stand

6. If adjustable, how long to do you stand at your desk in total during a typical work day?

_____ Minutes

7. Do you stand up for any other tasks during the day e.g. meetings?
Tick all that apply

- ☐ Meetings
- ☐ Standing required for role
- ☐ No standing required
- ☐ Other - please indicate

_____

8. Rate the impact of your desk or workstation on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

9. In a typical day, how long do you spend sitting in the chair provided?

Minutes

10. Rate the impact of your chair on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

11. Have you had any training or instruction on how or why to use your desk or chair properly?

- Yes
- No
- Not sure

12. What sort of training or instruction did you receive?
Tick all that apply

- ☐ Written instructions
- ☐ Online training
- ☐ Individual training session
- ☐ Group training session
- ☐ Other - please indicate

13. Have you had any ongoing follow-up training or information on using your desk or chair?

- ○ Yes - in person
- ○ Yes - via digital methods
- ○ No

Section 1.2: Office layout

14. In general, how satisfied are you with your work area's layout?

- ○ Very unsatisfied
- ○ Somewhat unsatisfied
- ○ Neither satisfied or unsatisfied
- ○ Somewhat satisfied
- ○ Very satisfied

15. Which one of the following best describes your normal work area?

- Private office
- Shared private office
- Open plan with high desk partitions 1.5 metres (from floor) or more
- Open plan lower desk partitions less than 1.5 metres (from floor
- Open plan without desk partitions
- Other - please indicate

16. Rate the impact of this layout on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

17. If you have moved to an open plan workplace, have you noticed any health impacts?

- Have always been in open plan
- Fewer sick days off
- No change between different workplaces
- More sick days off
- Not sure

18. Approximately how many more sick days do you have off per year since moving to open plan?

19. Do you have to walk far to use kitchen and bathroom facilities?

	No - close to desk	Yes - same floor but more than 3 minutes	Yes - different floor
Kitchen	○	○	○
Bathroom	○	○	○

20. Rate the impact of the distance to kitchen and bathroom facilities on your health

- ○ Significant negative impact
- ○ Minimal negative impact
- ○ Neutral - no impact
- ○ Minimal positive impact
- ○ Significant positive impact

21. Rate the impact of this ABW office on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

22. Do you choose settings or spaces where you can stand instead of spaces with standard desk height and seating?

- Yes - always
- Yes - sometimes
- No - I choose not to use a standing setting
- No - I'm not able to choose

23. When you choose different places to work or meet, do you consider your health?

- Yes- always
- Yes- sometimes
- No- I haven't really thought about it
- No- my health is not a priority at work

24. Rate your ability to choose where you work on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

25. Does your office have easily accessible internal staircases?

- Yes- stairs are part of office design
- Yes- fire stairs are open to use
- No - security or other limitations stop access
- Not applicable - single floor- we don't have stairs

26. In a typical day, how many times do you use the stairs instead of lifts between work floors?

27. Rate the impact of access to internal stairs on your health

- ○ Significant negative impact
- ○ Minimal negative impact
- ○ Neutral - no impact
- ○ Minimal positive impact
- ○ Significant positive impact

28. Which of these best describe your current desking arrangement?

- ○ Fixed location- I have my own desk/ sit at same desk every day
- ○ No fixed location-I move to a different desk every day
- ○ No fixed location- I move to a different desk some days

29. What type of desking arrangement do you prefer?

- ○ Have own desk
- ○ All desks are shared
- ○ Other - please indicate

30. Rate the impact of desking type on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

Section 1.3: Indoor environmental quality

31. In general, how satisfied you are with your work area's indoor environmental quality?

- Very unsatisfied
- Somewhat unsatisfied
- Neither satisfied or unsatisfied
- Somewhat satisfied
- Very satisfied

32. In general, how does the overall indoor environment impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

33. In a typical week, how does the air quality in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

34. In a typical week last Winter, how did the temperature of your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

35. In a typical week last Summer, how did the temperature of your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

36. In a typical week, how does your access to daylight in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

37. In a typical week, how does the quality of office lighting in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

38. In a typical week, how does the noise or acoustics in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

Section 2: Interventions beyond workplace design

39. Does [redacted] allow for flexible hours?

- Yes - company wide
- Yes- within my department or team
- No - set working hours
- Informal arrangement

40. Do you have any comments about flexible working hours?

41. Rate the impact of flexible or set hours on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

42. Can you choose the geographic location of where you work? For example, in office, at home, local cafe, co-working space.

- Yes - full choice
- Yes - some flexibility of location
- No choice- need to be in office during working hours

43. Rate the impact of your work location on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

44. How long is your typical commute to work ONE way? Journey time from home to workplace?

Minutes

45. Rate the impact of your commuting time on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

46. Do you use end of trip facilities (ETF) in order to bike/run/walk to work?

- Yes - regularly
- Yes - occasionally
- No - I don't wish to bike/run
- No - I can't bike/run/walk because no adequate facilities
- No- I bike/run/walk but choose not to use facilities

47. Rate the impact of end of trip facilities on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact
- Not applicable

48. Indicate your access to gym facilities

- Yes - onsite and free
- Yes - onsite and need to pay
- Yes - close by and free
- Yes - close by and need to pay
- No access

49. Rate the impact of access to gym facilities on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

50. Does [redacted] offer any incentives to being healthier (e.g. gym membership, health seminars, corporate sporting events)?

- No
- Yes - please indicate

51. Rate the impact of access to health promotions on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

52. Please indicate how important the following are to your health, with 1 being highly important and 7 being not important at all.

	1 - highly important	2	3	4	5	6	7 - not important at all	8 - not applicable
Choice of work location	○	○	○	○	○	○	○	○
Choice of flexible hours	○	○	○	○	○	○	○	○
Commuting time	○	○	○	○	○	○	○	○
End of trip facilities	○	○	○	○	○	○	○	○
Access to gym	○	○	○	○	○	○	○	○
Employer health programs	○	○	○	○	○	○	○	○
Type of desk	○	○	○	○	○	○	○	○
Type of chair	○	○	○	○	○	○	○	○
Density of space / proximity to other people	○	○	○	○	○	○	○	○
Openness of office layout	○	○	○	○	○	○	○	○
Variety of work settings	○	○	○	○	○	○	○	○
Ability to use stairs between floors	○	○	○	○	○	○	○	○
Ability to choose different desks	○	○	○	○	○	○	○	○
Indoor air quality	○	○	○	○	○	○	○	○
Thermal comfort	○	○	○	○	○	○	○	○
Access to daylight	○	○	○	○	○	○	○	○
Adequate lighting	○	○	○	○	○	○	○	○
Acoustics or noise levels	○	○	○	○	○	○	○	○
Enter another option	○	○	○	○	○	○	○	○
Enter another option	○	○	○	○	○	○	○	○

Section 3: SF12 Health Survey

53. In general, would you say your health is

- Excellent
- Very good
- Good
- Fair
- Poor

54. A. Does your health limit you in moderate activities, such as moving a table, pushing a vacuum, bowling, playing golf? If so, how much?

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

55. B. Does your health limit you in climbing several flights of stairs? If so, how much?

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

56. A. Accomplished less than you would like

- Yes
- No

57. B. Were limited in the kind of work or other activities

- Yes
- No

58. A. Accomplished less than you would like

- Yes
- No

59. B. Did not do work or other activities as carefully as usual

- Yes
- No

60. During the past 4 weeks how much did pain interfere with your normal work (Including work both outside the home and housework)?
Please tick one

- Not at all
- A little bit
- Moderately
- Quite a bit
- Extremely

61. These questions are about how you feel and how things have been with you during the past month. For each question, please Indicate the one answer that comes closest to the way you have been feeling.
Please select one on each line

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Have you felt calm and peaceful?	○	○	○	○	○	○
Did you have a lot of energy?	○	○	○	○	○	○
Have you felt down-hearted and low?	○	○	○	○	○	○
Has your health limited your social activities (like visiting friends or close relatives)?	○	○	○	○	○	○

Section 4: General participant work status

62. How old are you?

- ○ 30 years or under
- ○ 31 to 50 years
- ○ Over 50 years

63. What is your gender?

- Female
- Male
- Other
- Prefer not to say

64. Which of the following best describes the type of work you do?

- Administrative
- Technical/ Supporting Role
- Professional/ Mid level
- Managerial/ Senior Executive
- Other - please indicate

65. How long have you been working in this building?

- Less than 6 months
- 6-12 months
- 1-2 years
- 2-5 years
- More than 5 years

66. In a typical week, how long do you spend in your normal work area?

Hours

Appendix B After-move survey

[redacted]- New office. April 2019

Introduction

1. I have read the above information and agree to participate in the survey *

- I agree
- I do not agree

2. Which office address did you move from?

- [redacted]ce

3. Which office are you now located in?

- [redacted]
- [redacted]

4. It is critical that we can link your last survey response from [redacted]t or E[redacted]without identifying you. Could you please write the number or word that you entered last time such as the last 4 digits of your mobile number. We can match your answers to the two surveys without identifying you. If you dont have this code or word, please move to the next question.

Section 1.1: Individual desk/workstation and chair setup

5. In general, how satisfied you are with your work area's furnishings such as the desk and chair

- ○ Very unsatisfied
- ○ Somewhat unsatisfied
- ○ Neither satisfied or unsatisfied
- ○ Somewhat satisfied
- ○ Very satisfied

6. While at your desk, how long to do you stand at your desk in total during a typical work day?

_____ Minutes OR

_____ Hours

7. Do you stand up for any other tasks during the day e.g. meetings?
Tick all that apply

- ☐ Meetings
- ☐ Standing required for role
- ☐ No standing required
- ☐ Other - please indicate

_____

8. Rate the impact of your desk or workstation on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

9. In a typical day, how long do you spend sitting in the chair provided?

Minutes OR

Hours

10. Rate the impact of your chair on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

11. Have you had any training or instruction on how or why to use your desk or chair properly?

- ○ Yes
- ○ No
- ○ Not sure

12. What sort of training or instruction did you receive?
Tick all that apply

- ☐ Written instructions
- ☐ Online training
- ☐ Individual training session
- ☐ Group training session
- ☐ Other - please indicate

13. Have you had any ongoing follow-up training or information on using your desk or chair?

- ○ Yes - in person
- ○ Yes - via digital methods
- ○ No

Section 1.2: Office layout

14. In general, how satisfied are you with your work area's layout?

- Very unsatisfied
- Somewhat unsatisfied
- Neither satisfied or unsatisfied
- Somewhat satisfied
- Very satisfied

15. Which one of the following best describes your normal work area?

- Private office
- Shared private office
- Open plan with high desk partitions 1.5 metres (from floor) or more
- Open plan lower desk partitions less than 1.5 metres (from floor
- Open plan without desk partitions
- Other - please indicate

16. Rate the impact of this layout on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

17. If you have moved to an open plan workplace, have you noticed any health impacts?

- ○ Have always been in open plan
- ○ Fewer sick days off
- ○ No change between different workplaces
- ○ More sick days off

18. Approximately how many more sick days do you have off per year since moving to open plan?

19. Do you have to walk far to use kitchen and bathroom facilities?

	No - close to desk	Yes - same floor but more than 3 minutes	Yes - different floor
Kitchen	○	○	○
Bathroom	○	○	○

20. Rate the impact of the distance to kitchen and bathroom facilities on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

21. Rate the impact of this Activity Based Working (ABW) office on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

22. Do you choose settings or spaces where you can stand instead of spaces with standard desk height and seating?

- Yes - always
- Yes - sometimes
- No - I choose not to use a standing setting
- No - I'm not able to choose

23. When you choose different places to work or meet, do you consider your health?

- Yes- always
- Yes- sometimes
- No- I haven't really thought about it
- No- my health is not a priority at work

24. Rate your ability to choose where you work on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

25. Does your office have easily accessible internal staircases?

- Yes- stairs are part of office design
- Yes- fire stairs are open to use
- No- security or other limitations stop access
- Not applicable - single floor- we don't have stairs

26. In a typical day, how many times do you use the stairs instead of lifts between work floors?

27. Rate the impact of access to internal stairs on your health

- ○ Significant negative impact
- ○ Minimal negative impact
- ○ Neutral - no impact
- ○ Minimal positive impact
- ○ Significant positive impact

28. Which of these best describe your current desking arrangement?

- ○ Fixed location- I have my own desk/ sit at same desk every day
- ○ No fixed location-I move to a different desk every day
- ○ No fixed location- I move to a different desk some days

29. What type of desking arrangement do you prefer?

- ○ Have own desk
- ○ All desks are shared
- ○ Other - please indicate

30. Rate the impact of the desking arrangement on your health

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

Section 1.3: Indoor environmental quality

31. In general, how satisfied are you with your work area's indoor environmental quality?

- Very unsatisfied
- Somewhat unsatisfied
- Neither satisfied or unsatisfied
- Somewhat satisfied
- Very satisfied

32. In general, how does the overall indoor environment quality impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

33. In a typical week, how does the air quality in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

34. In a typical week last Winter, how did the temperature of your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

35. In a typical week last Summer, how did the temperature of your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

36. In a typical week, how does your access to daylight in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

37. In a typical week, how does the quality of office lighting in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

38. In a typical week, how does the noise or acoustics in your normal work area impact your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

Section 2: Interventions beyond workplace design

39. Does [redacted] allow for flexible hours?

- Yes - company wide
- Yes- within my department or team
- No - set working hours
- Informal arrangement

40. Do you have any comments about flexible working hours?

41. Rate the impact of flexible or set hours on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

42. Can you choose the geographic location of where you work? For example, in office, at home, local cafe, co-working space.

- Yes - full choice
- Yes - some flexibility of location
- No choice- need to be in office during working hours

43. Rate the impact of your ability to choose work location on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

44. How long is your typical commute to work ONE way? Journey time from home to workplace?

Minutes

45. Rate the impact of your commuting time on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

46. Do you use end of trip facilities (ETF) in order to bike/run/walk to work?

- Yes - regularly
- Yes - occasionally
- No - I don't wish to bike/run
- No - I can't bike/run/walk because no adequate facilities
- No- I bike/run/walk but choose not to use facilities

47. Rate the impact of end of trip facilities on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact
- Not applicable

48. Indicate your access to gym facilities

- Yes - onsite and free
- Yes - onsite and need to pay
- Yes - close by and free
- Yes - close by and need to pay
- No access

49. Rate the impact of access to gym facilities on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

50. Does [redacted] offer any incentives to being healthier (e.g. gym membership, health seminars, corporate sporting events)?

- No
- Yes - please indicate

51. Rate the impact of access to health promotions on your health?

- Significant negative impact
- Minimal negative impact
- Neutral - no impact
- Minimal positive impact
- Significant positive impact

52. Please indicate how important the following are to your health, with 1 being highly important and 7 being not important at all.

	1 - highly important	2	3	4	5	6	7 - not important at all
Choice of work location	○	○	○	○	○	○	○
Choice of flexible hours	○	○	○	○	○	○	○
Commuting time	○	○	○	○	○	○	○
End of trip facilities	○	○	○	○	○	○	○
Access to gym	○	○	○	○	○	○	○
Employer health programs	○	○	○	○	○	○	○
Type of desk	○	○	○	○	○	○	○
Type of chair	○	○	○	○	○	○	○
Density of space / proximity to other people	○	○	○	○	○	○	○
Openness of office layout	○	○	○	○	○	○	○
Variety of work settings	○	○	○	○	○	○	○
Ability to use stairs between floors	○	○	○	○	○	○	○
Ability to choose different desks	○	○	○	○	○	○	○
Indoor air quality	○	○	○	○	○	○	○
Thermal comfort	○	○	○	○	○	○	○
Access to daylight	○	○	○	○	○	○	○
Adequate lighting	○	○	○	○	○	○	○
Acoustics or noise levels	○	○	○	○	○	○	○
Enter another option	○	○	○	○	○	○	○
Enter another option	○	○	○	○	○	○	○

Section 3: SF12 Health Survey

53. In general, would you say your health is

- Excellent
- Very good
- Good
- Fair
- Poor

54. A. Does your health limit you in moderate activities, such as moving a table, pushing a vacuum, bowling, playing golf? If so, how much?

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

55. B. Does your health limit you in climbing several flights of stairs? If so, how much?

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

56. A. Accomplished less than you would like

- Yes
- No

57. B. Were limited in the kind of work or other activities

- Yes
- No

58. A. Accomplished less than you would like

- Yes
- No

59. B. Did not do work or other activities as carefully as usual

- Yes
- No

60. During the past 4 weeks how much did pain interfere with your normal work (Including work both outside the home and housework)?
Please tick one

- Not at all
- A little bit
- Moderately
- Quite a bit
- Extremely

61. These questions are about how you feel and how things have been with you during the past month. For each question, please Indicate the one answer that comes closest to the way you have been feeling.
Please select one on each line

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
Have you felt calm and peaceful?	○	○	○	○	○	○
Did you have a lot of energy?	○	○	○	○	○	○
Have you felt down-hearted and low?	○	○	○	○	○	○
Has your health limited your social activities (like visiting friends or close relatives)?	○	○	○	○	○	○

Section 4: General participant work status

62. How old are you?

- ○ 30 years or under
- ○ 31 to 50 years
- ○ Over 50 years

63. What is your gender?

- Female
- Male
- Other
- Prefer not to say

64. Which of the following best describes the type of work you do?

- Administrative
- Technical/ Supporting Role
- Professional/ Mid level
- Managerial/ Senior Executive
- Other - please indicate

65. In a typical week, how long do you spend in your normal work area?

Hours

Appendix C Before and after-move interview questions

Post Move Key Informants Semi structured interviews- Example questions and format

Principal Objective: Understand the context and design intent of the post move workplace and the perceived functionality of the daily operations of the new space. Post move interviews will include some reflective questions to review if these objectives have been fulfilled and understanding the functioning of the new workplace. Gaining some comparisons and information of the differences of the two environments is also important in this interview.

Questions will vary depending on the interviewee and their role in the organisation and workplace implementation or management.

Commencement of Interview

Explanation of the study and purpose of the interview

Informed consent and signing of Consent form and confirmation of confidentiality

1.0 OPENING GENERAL QUESTIONS

Objective: General background and relationship of person to organisation and workplace. A general 'warm up' with general information about the informant and their views.

For: All Key Informants- will vary depending on person and role

Tell me about your role in the design, implementation or facilitation of this workplace

How long have you been part of this process or in your current role?

Do you know what were the key objectives when the space was designed? Have they been realised?

What do people say about this workplace? What spaces or elements do they like compared to the last office?

Tell me what you think has been the most successful part of the new office?

2.0 HEALTH OF EMPLOYEES

For: Internal HR Manager, Internal Managers, OHS or Health consultant, Ergonomist

Objective of questions: To understand if and what discussions and actions are being taken regarding employee health and wellbeing in the company and how it is being measured

Is health and wellbeing of employees a conversation or implemented policy within the organisation? If it is a policy, please outline the objectives of it.

Is health and well-being of employees a priority? What are viewed as the most important health issues?

Are you proactively addressing employee health? What are the health-related policies?

How is it being implemented? Is there any measurement? If so, what measurement tools? How often and over what period?

Are you able to share the current rate of absenteeism? Is there any indication of change since the move?

Do you ask employees what their preferences are regarding matters or interventions that could impact their health at work?

Have you been part of the workplace design process? If so, what is the level of your involvement?

3.0 EMPLOYEE HEALTH AND THE WORKPLACE DESIGN

For: Interior designers, Project Managers, Workplace Implementation consultant associated with Case Study either pre-and/or post move.

Objective of questions: To specifically understand the relationships between company priorities, employee involvement and health knowledge in relation to workplace briefing and design.

Is employee health a consideration in the design briefs? Was employee health a consideration for this new office?

Tell me about how was the design brief created for this organisation?

Staff engagement/consultation?

If so, what is requested? What is deemed to make a difference?

As a designer, who do you learn/hear about what is important to individuals when it comes to their health in the workplace?

What do you think will make a difference? What elements or features of this workplace make a difference to occupant health?

How do you inform yourself of what works in terms of employee health?

4.0 THE DESIGN AND IMPLEMENTATION PROCESS

For: External designers or external workplace consultants involved in project

Objective of questions: To understand how the workplace brief was developed and if there is any discourse between these expectations and actual occupant experience (shown in later surveys)

Who from the organisation provided the brief for this new office? What is it based on? Any data or observational studies?

Staff engagement? What types of staff engagement are used? Surveys?

Where did the client get their information from? Who/what is the source of information for workplace and employee issues?

What were the key drivers or priorities for the organisation when considering workplace?

Was there any specific health drivers or health related issues or health policies discussed or prioritised?

5.0 GAPS/SHORTCOMINGS IN CURRENT WORKPLACE DESIGN

For: All Key Informants- will vary depending on person and role

Objective of questions: To identify any and what gaps in the process of workplace implementation and final design and what the ramifications are for the occupants.

Can you identify any gaps or shortcomings in the process of designing and creating the workplace?

Why do you think these gaps exist?

Who are the winners/losers of this current workplace? Examples of both?

What elements or design interventions in the office do you think impact of peoples' health?

Are there any elements that you think have a negative impact on health?

(For post move) What design elements have changed since the old office that have a positive effect or occupants' health?

Closing of interview

Explain next steps- recorded audio will be transcribed and they are able to check it if needed

Explain the value and importance of their time and input

THANK YOU!

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Interviewee: [redacted]

Role:

This is a semi structured interview so questions asked and issues discussed may vary on the day.

Commencement of Interview

Explanation of the study and purpose of the interview

Informed consent and signing of Consent form and confirmation of confidentiality

1.0 GENERAL QUESTIONS

Tell me about your role in the design, implementation or facilitation of this workplace

How long have you been part of this process or in your current role?

Do you know what were the key objectives when the space was designed? Have they been realised?

What do people say about this workplace? What spaces or elements do they like?

Tell me what you think has been the most successful part of the office? And what can be improved or changed for the next office?

2.0 EMPLOYEE HEALTH AND THE WORKPLACE DESIGN

Have you been part of the workplace design process? If so, what is the level of your involvement?

Is employee health a consideration in the design briefs? Was employee health a consideration for this office?

Do you ask employees what their preferences are regarding matters or interventions that could impact their health at work?

Staff engagement/consultation?

If so, what is requested? What is deemed to make a difference?

Who do you learn/hear about what is important to individuals when it comes to their health in the workplace?

What do you think will make a difference? What elements or features of this workplace make a difference to occupant health?

How do you inform yourself of what works in terms of employee health?

3.0 THE DESIGN AND IMPLEMENTATION PROCESS

What were the key drivers or priorities for the organisation when considering workplace?

Was there any specific health drivers or health related issues or health policies discussed or prioritised?

Who from the organisation provided the brief? What is it based on? Any data or observational studies?

Staff engagement? What types of staff engagement are used? Surveys?

Where did the client get their information from? Who/what is the source of information for workplace and employee issues?

4.0 GAPS/SHORTCOMINGS IN CURRENT WORKPLACE DESIGN

Can you identify any gaps or shortcomings in the process of designing and creating the workplace?

Why do you think these gaps exist?

Who are the winners/losers of this current workplace? Examples of both?

What elements or design interventions in the office do you think impact of peoples' health?

Are there any elements that you think have a negative impact on health?

(For post move) What design elements have changed since the old office that have a positive effect or occupants' health?

Closing of interview

Explain next steps- recorded audio will be transcribed and they are able to check it if needed

Explain the value and importance of their time and input

THANK YOU!

Appendix D Information and Consent Form for Interviews

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PARTICIPANT INFORMATION SHEET
Investigation of the relationship between the office workplace and perceived health

WHO IS DOING THE RESEARCH?
My name is Kirsten Brown and I am a Research student at UTS. My supervisors are Professor Christine Duffield, A/Professor Leena Thomas and A/Professor Alison Dawson.

WHAT IS THIS RESEARCH ABOUT?
The purpose of this research is to understand the relationship between the physical workplace environment and the impact on your perceived health.

[redacted]

IF I SAY YES, WHAT WILL IT INVOLVE?
If you decide to participate, I will invite you to participate in an audio recorded interview that will take approximately 30-40 minutes at both stages of the pre and post office relocation. The audio recording will be later transcribed and can be provided to you for review and checking if requested.

Personal details such as your name or any other identifying factors will not be recorded.

You can change your mind at any time and stop completing the survey without consequences.

ARE THERE ANY RISKS/INCONVENIENCE?
Yes, there are some risks/inconvenience. Time of approximately 30-40 minutes is required for the interview at the existing workplace or future workplace. For those involved in both sites, two interviews will be requested. Questions asked may be difficult to respond to if the participant feels uncomfortable

DO I HAVE TO SAY YES?
Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?
If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Kirsten Brown.

If you withdraw from the study, any audio recordings of interviews will be erased and the transcripts will be destroyed. You should be aware that data collected up to the time you withdraw will form part of the research project results.

CONFIDENTIALITY
By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially, not identifiable and will only be accessed by the student researcher and nominated UTS Supervisors. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law.

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We would like to store your information for future use in research projects that are an extension of this research project. In all instances your information will be treated confidentially.

We plan to discuss/publish the results as the final PhD thesis, possible conference papers or industry journals. In any publication, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact me (us) on [redacted] or my Supervisor, Christine Duffield on [redacted].

You will be given a copy of this form to keep.

NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONSENT FORM
Investigation of the relationship between the office workplace and perceived health

I _____ agree to participate in the research project to understand the relationship between the physical workplace environment and the impact on your perceived health.
UTS HREC approval reference number being conducted by *Kirsten Brown (phone [redacted])*.

I have read the Participant Information Sheet, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to be:
☐ Audio recorded

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way
☐ May be used for future research purposes

I am aware that I can contact Kirsten Brown if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

Kirsten Brown_____ ____/____/____
Name and Signature [researcher or delegate] Date

Appendix E Ethics Approval

Your ethics application has been approved as low risk - ETH18-2529

R

research.ethics@uts.edu.au

Reply all

Fri 08/06, 11:43

Kirsten Lee Brown;
Christine Duffield;
Chris Fernandes;
Karen Gomez;
Priya Nair;
Rebekah Tatian

Inbox

Flag for follow up. Start by 19 June 2018. Due by 19 June 2018.

Dear Applicant

Your local research office has reviewed your application titled, "What really matters to office workers' health? Investigation of the relationship between designed elements or interventions in the office workplace and the impact of perceived health of individuals.", and agreed that the application meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). I am pleased to inform you that ethics approval has now been granted.

Your approval number is UTS HREC REF NO. ETH18-2529.
You should consider this your official letter of approval. If you require a hardcopy please contact your local research office.

Approval will be for a period of five (5) years from the date of this correspondence subject to the provision of annual ethics reports to your local research office.

Your approval number must be included in all participant material and advertisements. Any advertisements on the UTS Staff Connect without an approval number will be removed.

Please note that the ethical conduct of research is an on-going process. The National Statement on Ethical Conduct in Human Research (2007) requires us to obtain reports about the progress of the research, and in particular about any changes to the research which may have ethical implications. You will be contacted when it is time to complete your first report.

Please refer to the AVCC guidelines relating to the storage of data, which require that data

be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

To access this application, please follow the URLs below:
* if accessing within the UTS network: https://rm.uts.edu.au
* if accessing outside of UTS network: https://vpn.uts.edu.au , and click on " RM6 – Production " after logging in.

If you have any queries about this approval, or require any amendments to your approval in future, please do not hesitate to contact your local research office or Research.Ethics@uts.edu.au.

REF: 12a

Appendix F Additional statistical analyses

Before-move comparative descriptive tables

Appendix Table 9.1 Demographics for before-move Site A and Site B

Q.62,63,64	Site A N (%)	Site B N (%)	X^2 (df)	p	Overall N (%)
Age					
30 years or under	**22 (18.5%)**	**27 (14.5%)**	**1.377 (2)**	**0.502**	**49 (16.1%)**
31 to 50 years	**66 (55.5%)**	**115 (61.8%)**			**181 (59.3%)**
Over 50 years	**31 (26.1%)**	**44 (23.7%)**			**75 (24.6%)**
Gender					
Female	**49 (40.5%)**	**101 (54.3%)**	**5.666 (2)**	**0.059**	**150 (48.9%)**
Male	**70 (57.9%)**	**82 (44.1%)**			**152 (49.5%)**
Other	**0 (0.0%)**	**0 (0.0%)**			**0 (0.0%)**
Prefer not to say	**2 (1.7%)**	**3 (1.6%)**			**5 (1.6%)**
Work role					
Administrative	**8 (6.6%)**	**39 (21.0%)**	**12.09 (4)**	**0.017**	**47 (15.3%)**
Technical/ Supporting Role	**27 (22.3%)**	**32 (17.2%)**			**59 (19.2%)**
Professional/ Mid-level	**76 (62.8%)**	**99 (53.2%)**			**175 (57.0%)**
Managerial/ Senior Executive	**9 (7.4%)**	**14 (7.5%)**			**23 (7.5%)**
Other	**1 (0.8%)**	**2 (1.1%)**			**3 (1.0%)**

Appendix Table 9.2 Hours worked per week for before-move Site A and Site B

Q. 66	Site A Mean (SD)	Site B Mean (SD)	MWU	p	Overall Mean (SD)
Work hours per week	**38.8 (10.41)**	**38.7 (9.61)**	**11119.5**	**0.987**	**38.8 (9.92)**

Appendix Table 9.3 Description of office settings at Site A and Site B

Q. 15	Site A N (%)	Site B N (%)	X^2 (df)	*p*-value	Over all N (%)
Private office	**0 (0.0%)**	**1 (0.3%)**	**19.661 (5)**	**0.001**	**(0.0%)**
Shared private office	**1 (0.8%)**	**6 (2.0%)**			**(0.0%)**
Open plan with high desk partitions 1 5 metres (from floor) or more	**43 (35.5%)**	**79 (25.7%)**			**(0.0%)**
Open plan lower desk partitions less than 1 5 metres (from floor	**76 (62.8%)**	**204 (66.4%)**			**(0.0%)**
Open plan without desk partitions	**0 (0.0%)**	**15 (4.9%)**			**(0.0%)**
Other	**1 (0.8%)**	**2 (0.7%)**			**(0.0%)**

Appendix Table 9.4 Distance to amenities for Site A and Site B

Q.19	**Site A N (%)**	**Site B N (%)**	**X^2 (df)**	**p**	**Overall N (%)**
Access to internal stairs	12 (10.0%)	94 (50.5%)	52.942 (1)	0.000	106 (34.6%)
Distance to kitchen					
Other floor	0 (0.0%)	0 (0.0%)	.070 (1)	0.791	0 (0.0%)
Same floor	10 (8.3%)	17 (9.1%)			27 (8.8%)

Very close	111 (91.7%)	169 (90.9%)			280 (91.2%)
Distance to bathroom					
Other floor	0 (0.0%)	0 (0.0%)	.764 (1)	0.382	0 (0.0%)
Same floor	12 (9.9%)	13 (7.1%)			25 (8.2%)
Very close	109 (90.1%)	170 (92.9%)			279 (91.8%)

Appendix Table 9.5: Choosing settings that allow for standing at Site A and Site B

Q.22	Site A N (%)	Site B N (%)	X^2 (df)	p	Overall A & B N (%)
Always	**4 (3.4%)**	**3 (1.6%)**	**4.332 (3)**	**0.228**	**7 (2.3%)**
I choose not to use a standing setting	**21 (17.6%)**	**23 (12.6%)**			**44 (14.6%)**
Sometimes	**15 (12.6%)**	**36 (19.8%)**			**51 (16.9%)**
I am not able to choose	**79 (66.4%)**	**120 (65.9%)**			**199 (66.1%)**

Appendix Table 9.6 Access to health facilities at Site A and Site B

Q.50	**Site A N (%)**	**Site B N (%)**	**X^2 (df)**	**p**	**Overall N (%)**
Gym access	50 (42.0%)	134 (72.0%)	27.33 (1)	0.000	184 (60.3%)
Health incentives offered	51 (42.9%)	93 (50.3%)	1.596 (1)	0.206	144 (47.4%)
Use end of trip facilities	78 (65.0%)	136 (73.5%)	2.520 (1)	0.112	214 (70.2%)

Appendix Table 9.7 Chair training at Site A and Site B

Q.12	**Site A N (%)**	**Site B N (%)**	**X^2 (df)**	**p**	**Overall N (%)**
Chair training	66 (55.0%)	58 (31.2%)	17.16 (1)	0.000	124 (40.5%)
Chair training - written	20 (30.3%)	15 (25.9%)	0.301 (1)	0.584	35 (28.2%)
Chair training - online	26 (39.4%)	22 (37.9%)	0.028 (1)	0.867	48 (38.7%)
Chair training - individual	19 (28.8%)	17 (29.3%)	0.004 (1)	0.949	36 (29.0%)
Chair training - group	13 (19.7%)	8 (13.8%)	0.765 (1)	0.382	21 (16.9%)
Chair training - other	4 (6.1%)	10 (17.2%)	3.853 (1)	0.050	14 (11.3%)
Chair training - follow up					
In person	3 (2.5%)	5 (2.7%)	1.070 (2)	0.586	8 (2.6%)
Digital	5 (4.2%)	4 (2.2%)			9 (3.0%)
No	111 (93.3%)	177 (95.2%)			288 (94.4%)

Appendix Table 9.8 Satisfaction at Site A and Site B

Q. 4, 14, 31	Site A N (%)	Site B N (%)	X^2 (df)	p	Overall N (%)
Satisfaction work area furnishings					
Very unsatisfied	10 (8.3%)	21 (11.3%)	3.343 (4)	0.502	31 (10.1%)
Somewhat unsatisfied	28 (23.3%)	49 (26.3%)			77 (25.2%)
Neither satisfied or unsatisfied	31 (25.8%)	35 (18.8%)			66 (21.6%)
Somewhat satisfied	39 (32.5%)	67 (36.0%)			106 (34.6%)
Very satisfied	12 (10.0%)	14 (7.5%)			26 (8.5%)
Satisfaction with work area layout					
Very unsatisfied	9 (7.4%)	11 (5.9%)	0.651 (4)	0.957	85 (6.5%)
Somewhat unsatisfied	32 (26.4%)	53 (28.6%)			81 (27.8%)
Neither satisfied or unsatisfied	34 (28.1%)	47 (25.4%)			99 (26.5%)
Somewhat satisfied	38 (31.4%)	61 (33.0%)			21 (32.4%)
Very satisfied	8 (6.6%)	13 (7.0%)			20 (6.9%)
Satisfaction with indoor environment					
Very unsatisfied	8 (6.6%)	12 (6.5%)	1.449 (4)	0.836	20 (6.5%)
Somewhat unsatisfied	41 (33.9%)	74 (39.8%)			115 (37.5%)
Neither satisfied nor unsatisfied	38 (31.4%)	57 (30.6%)			95 (30.9%)
Somewhat satisfied	28 (23.1%)	36 (19.4%)			64 (20.8%)
Very satisfied	6 (5.0%)	7 (3.8%)			13 (4.2%)

Before-move comparisons by demographics

Appendix Table 9.9 Importance of elements by Gender- before-move

Q.52	Female Mean (SD)	Male Mean (SD)	MWU	*p*-value
Importance - desk	5.6 (1.44)	5.3 (1.45)	10117	0.099
Importance - chair	5.8 (1.37)	5.7 (1.28)	10386	0.196
Importance - desk location	3.8 (1.98)	3.4 (2.02)	9965.5	0.101
Importance - office density	5.7 (1.28)	5.5 (1.37)	10058.5	0.083
Importance - openness	5.0 (1.50)	4.8 (1.53)	10455	0.280
Importance - setting variety	4.5 (1.83)	4.4 (1.69)	10436	0.316
Importance - stairs	4.5 (1.81)	4.3 (1.94)	10640.5	0.469
Importance - air quality	6.0 (1.21)	5.8 (1.24)	9989.5	0.117
Importance - thermal comfort	6.2 (1.10)	5.9 (1.21)	9110	0.003
Importance - daylight	6.2 (0.99)	5.8 (1.31)	8752	0.000
Importance - office lighting	6.2 (1.06)	5.9 (1.12)	9506.5	0.017
Importance - acoustics	5.9 (1.34)	5.6 (1.44)	10129	0.119
Importance - location choice	5.9 (1.38)	5.6 (1.48)	9379	0.020
Importance - flexible hours	6.1 (1.41)	5.8 (1.45)	9537.5	0.019
Importance - commute time	6.1 (1.25)	5.8 (1.44)	9811	0.042
Importance - ETF	3.4 (2.36)	3.9 (2.33)	9782	0.056
Importance - gym	3.9 (2.32)	3.7 (2.09)	10551.5	0.297
Importance - health incentives	4.6 (1.91)	4.3 (1.79)	10288.5	0.163

Appendix Table 9.10 Impact of element by Gender- before-move

	Female Mean (SD)	Male Mean (SD)	MWU	p
Impact - desk	2.3 (0.82)	2.5 (0.90)	9408.5	0.011
Impact - chair	2.4 (0.95)	2.7 (1.10)	9946.5	0.055
Impact - ABW	3.0 (0.80)	3.0 (0.64)	10596.5	0.640
Impact - desking arrangement	3.0 (1.02)	3.2 (1.09)	10041.5	0.162
Impact - layout	2.8 (0.79)	2.9 (0.82)	10358	0.124
Impact - stairs	2.8 (1.05)	2.8 (1.00)	3482	0.698
Impact - kitchen/bathroom proximity	3.2 (0.58)	3.1 (0.53)	11145	0.635
Impact - indoor environment	2.5 (0.81)	2.8 (0.90)	9073.5	0.001
Impact - air quality	2.5 (0.67)	2.9 (0.78)	8522.5	0.000
Impact - winter temperature	2.2 (0.79)	2.8 (0.77)	7132.5	0.000
Impact - summer temperature	2.5 (0.91)	2.7 (0.83)	9915	0.036
Impact - daylight	3.3 (1.10)	3.3 (1.14)	10955.5	0.685
Impact - office lighting	3.0 (0.95)	3.0 (0.92)	11014	0.584
Impact - acoustics	2.5 (0.86)	2.6 (0.90)	10602	0.261
Impact - location choice	3.4 (1.21)	3.5 (1.06)	10910.5	0.640
Impact - flexible hours	4.0 (1.22)	3.8 (1.21)	10297.5	0.216
Impact - commute time	2.7 (1.17)	2.7 (1.22)	11041	0.774
Impact - ETF	4.5 (1.37)	4.5 (1.31)	11019.5	0.749
Impact - gym	3.4 (1.11)	3.3 (0.92)	10802	0.510
Impact - health incentives	3.4 (1.02)	3.4 (0.99)	11166.5	0.907

Appendix Table 9.11 Satisfaction by Age- before-move

Q. 4, 14, 31	30 years or under	31 to 50 years	Over 50 years	K-W	p
Satisfaction work area furnishings	2.9 (1.10)	3.0 (1.13)	3.2 (1.26)	2.463	0.292
Satisfaction with work area layout	2.9 (1.00)	3.0 (1.03)	3.2 (1.20)	3.339	0.188
Satisfaction with indoor environment	2.6 (0.87)	2.8 (0.98)	3.0 (1.05)	4.508	0.105

Appendix Table 9.12 Satisfaction by Gender- before-move

Q. 4, 14, 31	Female Mean (SD)	Male Mean (SD)	MWU	p
Satisfaction with work area furnishings	3.0 (1.19)	3.2 (1.12)	10354	0.183
Satisfaction with work area layout	3.1 (1.07)	3.1 (1.07)	11306.5	0.980
Satisfaction with indoor environment	2.7 (0.96)	2.9 (1.00)	9750.5	0.023

Appendix Table 9.13 Activity by Age- before-move

Q. 6, 9,26,44	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	*p*-value
Standing at desk - minutes	0.0 (0.00)	83.1 (92.19)	71.0 (66.30)	4.027	0.134
Sitting at desk - minutes	570.0 (212.13)	395.5 (197.10)	350.0 (77.46)	2.280	0.320
Stairs - use per day	0.9 (1.23)	1.1 (1.36)	1.6 (2.04)	1.011	0.603
Commute time - minutes	43.1 (0.00)	45.7 (0.00)	48.0 (0.00)	2.221	0.329

Appendix Table 9.14 Activity by Gender- before-move

Q. 6, 9,26,44	Female Mean (SD)	Male Mean (SD)	MWU	p
Standing at desk - minutes	43.6 (59.04)	99.5 (94.60)	50.5	0.042
Sitting at desk - minutes	472.7 (205.77)	345.6 (154.27)	56.5	0.118
Stairs - use per day	0.9 (1.36)	1.5 (1.68)	1010	0.059
Commute time - minutes	45.6 (20.42)	46.5 (22.64)	11197.5	0.944

Appendix Table 9.15 SF-12 scores by Age- before-move

Q. 53-61	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	p
SF12 Physical Composite Score	**53.6 (4.42)**	**51.6 (7.83)**	**51.0 (8.36)**	**1.478**	**0.477**
SF12 Mental Composite Score	**45.3 (11.37)**	**48.6 (10.14)**	**49.7 (10.12)**	**5.384**	**0.068**
Sick days	**4.4 (1.52)**	**6.5 (9.09)**	**4.0 (1.41)**	**0.245**	**0.885**

Appendix Table 9.16 SF-12 scores by Gender- before-move

Q. 53-61	Female Mean (SD)	Male Mean (SD)	MWU	p
SF12 Physical Composite Score	51.1 (8.27)	52.5 (6.66)	9952	0.283
SF12 Mental Composite Score	47.6 (11.03)	49.2 (9.58)	9908	0.257
Sick days	7.3 (9.26)	3.4 (1.06)	24.5	0.062

Appendix Table 9.17 Demographics by Age- before-move

Q.62,63,64	30 years or under	31 to 50 years	Over 50 years	K-W	p
Gender					
Female	28 (57.1%)	97 (53.6%)	25 (33.3%)	14.654	0.005
Male	19 (38.8%)	81 (44.8%)	50 (66.7%)		
Other	0 (0.0%)	0 (0.0%)	0 (0.0%)		
Prefer not to say	2 (4.1%)	3 (1.7%)	0 (0.0%)		
Work role					
Administrative	7 (14.3%)	25 (13.8%)	15 (20.0%)	20.295	0.009
Technical/ Supporting Role	11 (22.4%)	36 (19.9%)	11 (14.7%)		
Professional/ Mid-level	31 (63.3%)	107 (59.1%)	36 (48.0%)		
Managerial/ Senior Executive	0 (0.0%)	10 (5.5%)	13 (17.3%)		
Other	0 (0.0%)	3 (1.7%)	0 (0.0%)		

Appendix Table 9.18 Demographics by Gender- before-move

Q.62,63,64	Female N (%)	Male N (%)	X^2	p
Age				
30 years or under	28 (18.7%)	19 (12.7%)	11.495	0.003
31 to 50 years	97 (64.7%)	81 (54.0%)		
Over 50 years	25 (16.7%)	50 (33.3%)		
Work role				
Administrative	37 (24.7%)	9 (5.9%)	35.702	0.000
Technical/ Supporting Role	18 (12.0%)	40 (26.3%)		
Professional/ Mid-level	89 (59.3%)	83 (54.6%)		
Managerial/ Senior Executive	4 (2.7%)	19 (12.5%)		
Other	2 (1.3%)	1 (0.7%)		

Appendix Table 9.19 Workplace elements by Age- before-move

Q. 29, 42,39,46,48,50,25	30 years or under	31 to 50 years	Over 50 years	K-W	p
Desk - preference					
Own desk	38 (79.2%)	152 (84.0%)	61 (82.4%)	2.756	0.599
Shared desks	8 (16.7%)	21 (11.6%)	12 (16.2%)		
Other	2 (4.2%)	8 (4.4%)	1 (1.4%)		
Choice of work location					
None	20 (40.8%)	58 (32.0%)	21 (28.0%)	2.603	0.626
Some	27 (55.1%)	110 (60.8%)	49 (65.3%)		
Full	2 (4.1%)	13 (7.2%)	5 (6.7%)		
Flexible hours	41 (83.7%)	163 (90.1%)	68 (90.7%)	1.855	0.395
Use end of trip facilities	30 (61.2%)	121 (67.6%)	61 (81.3%)	6.872	0.032
Gym access	27 (55.1%)	122 (67.8%)	34 (45.9%)	11.135	0.004
Health incentives offered	21 (42.9%)	93 (51.7%)	29 (39.7%)	3.444	0.179
Access to internal stairs	19 (39.6%)	62 (34.3%)	24 (32.0%)	0.761	0.684

Appendix Table 9.20 Workplace elements by Gender- before-move

Q. 29, 42,39,46,48,50,25	Female N (%)	Male N (%)	X^2	p
Desk - preference				
Own desk	123 (82.6%)	126 (83.4%)	.214	0.899
Shared desks	21 (14.1%)	19 (12.6%)		
Other	5 (3.4%)	6 (4.0%)		
Choice of work location				
None	45 (30.0%)	51 (33.6%)	.448	0.799
Some	95 (63.3%)	91 (59.9%)		
Full	10 (6.7%)	10 (6.6%)		
Flexible hours	134 (89.3%)	135 (88.8%)	.021	0.885
Gym access	92 (62.2%)	88 (57.9%)	.569	0.451
Health incentives offered	75 (51.0%)	68 (44.7%)	1.182	0.277
Access to internal stairs	55 (36.9%)	49 (32.2%)	.727	0.394

Appendix Table 9.21 Health choices and flexibility- Site A and Site B

Q. 22,39, 42, 46	Site A N (%)	Site B N (%)	X^2 (df)	p	Overall N (%)
Consider health when choosing settings					
Always	16 (13.8%)	22 (12.4%)	3.385 (3)	0.336	38 (12.9%)
Sometimes	34 (29.3%)	55 (30.9%)			89 (30.3%)
I haven't really thought about it	65 (56.0%)	93 (52.2%)			158 (53.7%)
My health is not a priority at work	1 (0.9%)	8 (4.5%)			9 (3.1%)
Flexible hours					
Company wide	39 (32.2%)	70 (37.6%)	11.117 (3)	0.011	109 (35.5%)
Department or team	59 (48.8%)	75 (40.3%)			134 (43.6%)
Set working hours	6 (5.0%)	27 (14.5%)			33 (10.7%)
Informal arrangement	17 (14.0%)	14 (7.5%)			31 (10.1%)
Choice of work location					
None	35 (28.9%)	64 (34.4%)	3.485 (2)	0.175	99 (32.2%)
Some	81 (66.9%)	107 (57.5%)			188 (61.2%)
Full	5 (4.1%)	15 (8.1%)			20 (6.5%)
ETF use					
Regularly	17 (14.2%)	24 (13.0%)	4.462 (4)	0.347	41 (13.4%)
Occasionally	61 (50.8%)	112 (60.5%)			173 (56.7%)
I don't wish to bike/run	10 (8.3%)	7 (3.8%)			17 (5.6%)
No adequate facilities	26 (21.7%)	34 (18.4%)			60 (19.7%)
Choose not to use facilities	6 (5.0%)	8 (4.3%)			14 (4.6%)

Appendix Table 9.22 Health choices by Age- before- move

Q. 22,39, 42, 46	30 years or under N (%)	31 to 50 years N (%)	Over 50 years N (%)	X^2 (df)	p
Consider health when choosing settings					
Always	5 (10.2%)	22 (12.9%)	11 (15.1%)	5.712 (6)	0.456
Sometimes	13 (26.5%)	51 (30.0%)	25 (34.2%)		
I haven't really thought about it	30 (61.2%)	89 (52.4%)	37 (50.7%)		
My health is not a priority at work	1 (2.0%)	8 (4.7%)	0 (0.0%)		
Flexible hours					
Company wide	17 (34.7%)	68 (37.6%)	24 (32.0%)	3.578 (6)	0.734
Department or team	21 (42.9%)	76 (42.0%)	37 (49.3%)		
Set working hours	8 (16.3%)	18 (9.9%)	7 (9.3%)		
Informal arrangement	3 (6.1%)	19 (10.5%)	7 (9.3%)		
Choice of work location					
None	20 (40.8%)	58 (32.0%)	21 (28.0%)	2.603 (4)	0.626
Some	27 (55.1%)	110 (60.8%)	49 (65.3%)		
Full	2 (4.1%)	13 (7.2%)	5 (6.7%)		
ETF use					
Regularly	6 (12.2%)	26 (14.5%)	9 (12.0%)	13.499 (8)	0.096
Occasionally	24 (49.0%)	95 (53.1%)	52 (69.3%)		
I don't wish to bike/run	6 (12.2%)	10 (5.6%)	1 (1.3%)		
No adequate facilities	12 (24.5%)	37 (20.7%)	11 (14.7%)		
Choose not to use facilities	1 (2.0%)	11 (6.1%)	2 (2.7%)		

Appendix Table 9.23 Health choices by Gender- before-move

Q. 22,39, 42, 46	Female N (%)	Male N (%)	X^2 (df)	p
Consider health when choosing settings				
Always	20 (13.7%)	18 (12.6%)	0.789 (3)	0.852
Sometimes	41 (28.1%)	46 (32.2%)		
I haven't really thought about it	81 (55.5%)	74 (51.7%)		
My health is not a priority at work	4 (2.7%)	5 (3.5%)		
Flexible hours				
Company wide	63 (42.0%)	45 (29.6%)	5.364 (3)	0.147
Department or team	59 (39.3%)	73 (48.0%)		
Set working hours	16 (10.7%)	17 (11.2%)		
Informal arrangement	12 (8.0%)	17 (11.2%)		
Choice of work location				
None	45 (30.0%)	51 (33.6%)	0.448 (2)	0.799
Some	95 (63.3%)	91 (59.9%)		
Full	10 (6.7%)	10 (6.6%)		
ETF use				
Regularly	16 (10.7%)	25 (16.6%)	3.477 (4)	0.481
Occasionally	92 (61.7%)	79 (52.3%)		
I don't wish to bike/run	7 (4.7%)	9 (6.0%)		
No adequate facilities	27 (18.1%)	31 (20.5%)		
Choose not to use facilities	7 (4.7%)	7 (4.6%)		

Appendix Table 9.24 Work hours by Age- before-move

Before-move- Q. 66	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	
Work hours	37.3 (10.18)	38.4 (10.48)	40.8 (7.97)	4.131	0.127

Appendix Table 9.25 Work hours by Gender- before-move

Before-move- Q. 66	Female	Male	MWU	p
Work hours	37.5 (10.13)	40.0 (9.71)	92553	0.007

After-move comparative descriptive tables

Appendix Table 9.26 Demographics Cohort A and Cohort B- after-move

Q.62,63,64	Cohort A N (%)	Cohort B N (%)	X^2 (df)	p
Age				
30 years or under	13 (15.5%)	13 (10.6%)	1.109 (2)	0.574
31 to 50 years	53 (63.1%)	83 (67.5%)		
Over 50 years	18 (21.4%)	27 (22.0%)		
Gender				
Female	28 (33.7%)	62 (50.4%)	10.557 (3)	0.014
Male	54 (65.1%)	57 (46.3%)		
Other	1 (1.2%)	0 (0.0%)		
Prefer not to say	0 (0.0%)	4 (3.3%)		
Work role				
Administrative	8 (9.5%)	23 (18.7%)	8.318 (4)	0.081
Technical/ Supporting Role	28 (33.3%)	25 (20.3%)		
Professional/ Mid-level	40 (47.6%)	58 (47.2%)		
Managerial/ Senior Executive	8 (9.5%)	14 (11.4%)		
Other	0 (0.0%)	3 (2.4%)		

Appendix Table 9.27 Work hours for Cohort A and Cohort B- after-move

Q. 66	Cohort A Mean (SD)	Cohort B Mean (SD)	MWU	*p*-value
Work hours	39.6 (9.80)	40.6 (11.99)	4486.5	0.136

Appendix Table 9.28 Description of office settings by Cohort- after-move

Q. 15 Layout - type	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Private office	0 (0.0%)	0 (0.0%)	6.379 (4)	0.173
Shared private office	1 (1.2%)	7 (5.7%)		
Open plan with high desk partitions 1 5 metres (from floor) or more	6 (7.1%)	6 (4.9%)		
Open plan lower desk partitions less than 1 5 metres (from floor	23 (27.4%)	47 (38.2%)		
Open plan without desk partitions	52 (61.9%)	60 (48.8%)		
Other	2 (2.4%)	3 (2.4%)		

Appendix Table 9.29 Distance to Amenities by Cohort- after-move

Q. 19	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Access to internal stairs	**29 (34.9%)**	**90 (73.2%)**	**29.69 (1)**	**0.000**
Distance to kitchen				
Other floor	**3 (3.6%)**	**7 (5.7%)**	**3.014 (2)**	**0.222**
Same floor	**11 (13.3%)**	**8 (6.5%)**		
Very close	**69 (83.1%)**	**108 (87.8%)**		
Distance to bathroom				
Other floor	**0 (0.0%)**	**0 (0.0%)**	**0.268 (1)**	**0.605**
Same floor	**12 (14.8%)**	**15 (12.3%)**		
Very close	**69 (85.2%)**	**107 (87.7%)**		

Appendix Table 9.30 Chair Training by Cohort- after-move

Q.11	Cohort A N (%)	Cohort B N (%)	X2 (df)	p-value
Chair training	**48 (57.8%)**	**64 (52.0%)**	**0.672 (1)**	**0.412**

Appendix Table 9.31 Access to stairs by Cohort- after-move

Q. 25	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Access to internal stairs	**29 (34.9%)**	**90 (73.2%)**	**29.69 (1)**	**0.000**

Appendix Table 9.32 Health facilities by Cohort- after-move

Q. 46,48,50	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Gym access	**36 (43.4%)**	**65 (52.8%)**	**1.779 (1)**	**0.182**
Health incentives offered	**26 (32.1%)**	**40 (32.8%)**	**0.011 (1)**	**0.918**
Use end of trip facilities	**59 (70.2%)**	**89 (72.4%)**	**0.11 (1)**	**0.740**

Appendix Table 9.33 Satisfaction by Cohort- after-move

Q. 4,14,31	Cohort A N (%)	Cohort B N (%)	X^2 (df)	*p*-value
Satisfaction with work area furnishings				
Very unsatisfied	**18 (21.4%)**	**20 (16.3%)**	**6.452 (4)**	**0.168**
Somewhat unsatisfied	**15 (17.9%)**	**14 (11.4%)**		
Neither satisfied nor unsatisfied	**10 (11.9%)**	**8 (6.5%)**		
Somewhat satisfied	**21 (25.0%)**	**44 (35.8%)**		
Very satisfied	**20 (23.8%)**	**37 (30.1%)**		
Satisfaction with work area layout	**0 (0.0%)**	**0 (0.0%)**		
Very unsatisfied	**9 (10.7%)**	**10 (8.1%)**	**2.754 (4)**	**0.600**
Somewhat unsatisfied	**22 (26.2%)**	**23 (18.7%)**		
Neither satisfied nor unsatisfied	**10 (11.9%)**	**17 (13.8%)**		
Somewhat satisfied	**24 (28.6%)**	**45 (36.6%)**		
Very satisfied	**19 (22.6%)**	**28 (22.8%)**		
Satisfaction with indoor environment	**0 (0.0%)**	**0 (0.0%)**		
Very unsatisfied	**6 (7.1%)**	**10 (8.1%)**	**0.485 (4)**	**0.975**
Somewhat unsatisfied	**29 (34.5%)**	**37 (30.1%)**		
Neither satisfied nor unsatisfied	**10 (11.9%)**	**16 (13.0%)**		
Somewhat satisfied	**27 (32.1%)**	**42 (34.1%)**		
Very satisfied	**12 (14.3%)**	**18 (14.6%)**		

Before-move / After-move comparative descriptive tables by cohort

Appendix Table 9.34 Demographics and Work hours- Cohort A- before and after-move

Cohort A- Q.62,63,64	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Age				
30 years or under	**22 (18.5%)**	**13 (15.5%)**	**1.184 (2)**	**0.553**
31 to 50 years	**66 (55.5%)**	**53 (63.1%)**		
Over 50 years	**31 (26.1%)**	**18 (21.4%)**		
Gender				
Female	**49 (40.5%)**	**28 (33.7%)**	**3.847 (3)**	**0.278**
Male	**70 (57.9%)**	**54 (65.1%)**		
Other	**0 (0.0%)**	**1 (1.2%)**		
Prefer not to say	**2 (1.7%)**	**0 (0.0%)**		
Work role				
Administrative	**8 (6.6%)**	**8 (9.5%)**	**5.759 (4)**	**0.218**
Technical/ Supporting Role	**27 (22.3%)**	**28 (33.3%)**		
Professional/ Mid-level	**76 (62.8%)**	**40 (47.6%)**		
Managerial/ Senior Executive	**9 (7.4%)**	**8 (9.5%)**		
Other	**1 (0.8%)**	**0 (0.0%)**		
	Mean (SD)	**Mean (SD**	**MWU**	**p**
Work hours	**38.8 (10.4)**	**39.6 (9.8)**	**4817.5**	**0.616**

Appendix Table 9.35 Office settings- Cohort A-before and after-move

Cohort A- Q.15	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Layout - type				
Private office	**0 (0.0%)**	**0 (0.0%)**	**105.40 (4)**	**0.000**
Shared private office	**1 (0.8%)**	**1 (1.2%)**		
Open plan with high desk partitions ≥1 5 metres from floor	**43 (35.5%)**	**6 (7.1%)**		
Open plan lower desk partitions < 1 5 metres from floor	**76 (62.8%)**	**23 (27.4%)**		
Open plan without desk partitions	**0 (0.0%)**	**52 (61.9%)**		
Other	**1 (0.8%)**	**2 (2.4%)**		

Appendix Table 9.36 Distance to amenities- Cohort A- before and after-move

Cohort A- Q19	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Access to internal stairs	**12 (10.0%)**	**29 (34.9%)**	**18.934 (1)**	**0.000**
Distance to kitchen				
Other floor	**0 (0.0%)**	**3 (3.6%)**	**5.977 (2)**	**0.050**
Same floor	**10 (8.3%)**	**11 (13.3%)**		
Very close	**111 (91.7%)**	**69 (83.1%)**		
Distance to bathroom				
Other floor	**0 (0.0%)**	**0 (0.0%)**	**1.112 (2)**	**0.292**
Same floor	**12 (9.9%)**	**12 (14.8%)**		
Very close	**109 (90.1%)**	**69 (85.2%)**		

Appendix Table 9.37 Desk location movement- Cohort A- before and after-move

Cohort A- Q.28	Before Move (n=121) N (%)	After Move (n=84) N (%)	X2 (df)	p
Desk location movement				
Never move	**118 (97.5%)**	**20 (23.8%)**	**122.64 (2)**	**0.000**
Move every day	**0 (0.0%)**	**18 (21.4%)**		
Move some days	**3 (2.5%)**	**46 (54.8%)**		

Appendix Table 9.38 Desk preference- Cohort A- before and after-move

Cohort A- Q. 29	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Desk - preference				
Own desk	**103 (85.1%)**	**56 (66.7%)**	**14.74**	**0.001**
Shared desks	**11 (9.1%)**	**25 (29.8%)**		
Other	**7 (5.8%)**	**3 (3.6%)**		

Appendix Table 9.39 Chair training- Cohort A- before and after-move

Cohort A- Q.11	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Chair training	**66 (55.0%)**	**48 (57.8%)**	**0.16**	**0.689**

Appendix Table 9.40 Health facilities- Cohort A- before and after-move

Cohort A-Q. 46,48,50	Before Move (n=121) N (%)	After Move (n=84) N (%)	X^2 (df)	p
Gym access	**50 (42.0%)**	**36 (43.4%)**	**0.037**	**0.848**
Health incentives offered	**51 (42.9%)**	**26 (32.1%)**	**2.356**	**0.125**
Use end of trip facilities	**78 (65.0%)**	**59 (70.2%)**	**0.615**	**0.433**

Appendix Table 9.41 Demographics Cohort B- before and after-move

Cohort B- Q.62,63,64	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Age				
30 years or under	**27 (14.5%)**	**13 (10.6%)**	**1.354 (2)**	**0.508**
31 to 50 years	**115 (61.8%)**	**83 (67.5%)**		
Over 50 years	**44 (23.7%)**	**27 (22.0%)**		
Gender				
Female	**101 (54.3%)**	**62 (50.4%)**	**1.175 (3)**	**0.556**
Male	**82 (44.1%)**	**57 (46.3%)**		
Other	**0 (0.0%)**	**0 (0.0%)**		
Prefer not to say	**3 (1.6%)**	**4 (3.3%)**		
Work role				
Administrative	**39 (21.0%)**	**23 (18.7%)**	**3.183 (4)**	**0.528**
Technical/ Supporting Role	**32 (17.2%)**	**25 (20.3%)**		
Professional/ Mid-level	**99 (53.2%)**	**58 (47.2%)**		
Managerial/ Senior Executive	**14 (7.5%)**	**14 (11.4%)**		
Other	**2 (1.1%)**	**3 (2.4%)**		
	Mean (SD)	**Mean (SD**	**MWU**	**p**
Work hours	**38.7 (9.6)**	**40.6 (12)**	**9611.5**	**0.023**

Appendix Table 9.42 Office settings- Cohort B- before and after-move

Cohort B- Q.15	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Layout - type				
Private office	**1 (0.5%)**	**0 (0.0%)**	**78.679 (4)**	**0.000**
Shared private office	**5 (2.7%)**	**7 (5.7%)**		
Open plan with high desk partitions ≥1 5 metres from floor	**36 (19.4%)**	**6 (4.9%)**		
Open plan lower desk partitions < 1 5 metres from floor	**128 (68.8%)**	**47 (38.2%)**		
Open plan without desk partitions	**15 (8.1%)**	**60 (48.8%)**		
Other	**1 (0.5%)**	**3 (2.4%)**		

Appendix Table 9.43 Distance to facilities- Cohort B- before and after-move

Cohort B-Q.19	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Access to internal stairs	**94 (50.5%)**	**90 (73.2%)**	**15.745 (1)**	**0.000**
Distance to kitchen				
Other floor	**0 (0.0%)**	**7 (5.7%)**	**11.298 (2)**	**0.004**
Same floor	**17 (9.1%)**	**8 (6.5%)**		
Very close	**169 (90.9%)**	**108 (87.8%)**		
Distance to bathroom				
Other floor	**0 (0.0%)**	**0 (0.0%)**	**2.366 (2)**	**0.124**
Same floor	**13 (7.1%)**	**15 (12.3%)**		
Very close	**170 (92.9%)**	**107 (87.7%)**		

Appendix Table 9.44 Desk location movement- Cohort B- before and after-move

Cohort B- Q. 28	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Desk location movement				
Never move	**171 (92.9%)**	**16 (13.0%)**	**198.85 (2)**	**0.000**
Move every day	**10 (5.4%)**	**57 (46.3%)**		
Move some days	**3 (1.6%)**	**50 (40.7%)**		

Appendix Table 9.45 Desk preference- Cohort B- before and after-move

Cohort B- Q.29	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Desk - preference				
Own desk	**150 (81.5%)**	**61 (49.6%)**	**35.287 (2)**	**0.000**
Shared desks	**30 (16.3%)**	**52 (42.3%)**		
Other	**4 (2.2%)**	**10 (8.1%)**		

Appendix Table 9.46 Health facilities- Cohort B- before and after-move

Cohort B- Q.50	Before Move (n=186) N (%)	After Move (n=124) N (%)	X^2 (df)	p
Gym access	**134 (72.0%)**	**65 (52.8%)**	**11.902 (1)**	**0.001**
Health incentives offered	**93 (50.3%)**	**40 (32.8%)**	**9.152 (1)**	**0.002**
Use end of trip facilities	**136 (73.5%)**	**89 (72.4%)**	**0.05 (1)**	**0.823**

Appendix Table 9.47 Health choices- Cohort A and Cohort B- after-move

Q. 22, 39,42, 46	Cohort A N (%)	Cohort B N (%)	X^2 (df)	p
Consider health when choosing settings				
Always	**12 (14.3%)**	**10 (8.4%)**	**2.143 (3)**	**0.543**
Sometimes	**27 (32.1%)**	**44 (37.0%)**		
I haven't really thought about it	**42 (50.0%)**	**59 (49.6%)**		
My health is not a priority at work	**3 (3.6%)**	**6 (5.0%)**		
Flexible hours				
Company wide	**28 (33.3%)**	**42 (34.1%)**	**3.393 (3)**	**0.335**
Department or team	**38 (45.2%)**	**59 (48.0%)**		
Set working hours	**5 (6.0%)**	**12 (9.8%)**		
Informal arrangement	**13 (15.5%)**	**10 (8.1%)**		
Choice of work location				
None	**20 (23.8%)**	**19 (15.7%)**	**2.123 (2)**	**0.346**
Some	**58 (69.0%)**	**92 (76.0%)**		
Full	**6 (7.1%)**	**10 (8.3%)**		
ETF use				
Regularly	**13 (15.5%)**	**18 (14.6%)**	**6.656 (4)**	**0.155**
Occasionally	**46 (54.8%)**	**71 (57.7%)**		
I don't wish to bike/run	**10 (11.9%)**	**4 (3.3%)**		
No adequate facilities	**11 (13.1%)**	**21 (17.1%)**		
Choose not to use facilities	**4 (4.8%)**	**9 (7.3%)**		

Consolidated Cohorts-working hours

Appendix Table 9.48 Work hours by Age

Q.66	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	p
Work hours	**40.8 (11.47)**	**40.8 (10.56)**	**38.5 (11.75)**	**0.549**	**0.760**

Appendix Table 9.49 Work hours by Gender

Q.66	Female	Male	MWU	p
Work hours	**39.6 (10.51)**	**40.9 (11.39)**	**5259.5**	**0.351**

Cohort A-working hours by age and gender

Appendix Table 9.50 Work hours by Age- Cohort A

Q.66	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	p
Work hours	**37.3 (9.58)**	**40.8 (9.92)**	**37.6 (9.48)**	**1.645**	**0.439**

Appendix Table 9.51 Work hours by Gender- Cohort A

Q.66	Female	Male	MWU	p
Work hours	**36.6 (10.92)**	**40.8 (9.08)**	**572.5**	**0.110**

Cohort B- working hours by age and gender

Appendix Table 9.52 Work Hours by Age- Cohort B

Q.66	30 years or under Mean (SD)	31 to 50 years Mean (SD)	Over 50 years Mean (SD)	K-W	p
Work hours	**44.1 (12.89)**	**40.5 (11.25)**	**39.0 (13.77)**	**0.171**	**0.918**

Appendix Table 9.53 Work Hours by Gender- Cohort B

Q.66	Female	Male	MWU	p
Work hours	**40.7 (10.71)**	**40.7 (13.52)**	**1678.5**	**0.634**