MA Research Report

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Going Green: Looking at the Impact of 'Green' Buildings on Organisational Outcomes

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I declare that this research report is my own, unaided work. It has not been submitted before for any other degree or examination at this or any other university.

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Abstract

The aim of this study was to determine the impact that Indoor Environmental Quality (IEQ) design features of green buildings, have on specific organisational outcomes. The organisational outcomes investigated were physical wellbeing, psychological wellbeing, productivity, absenteeism and job satisfaction. These outcomes were investigated within two different green buildings, belonging to a large financial institution, situated in Johannesburg and Durban.

Self-report questionnaires were distributed to employees via email inviting them to participate in the study. The questionnaires contained the Warwick-Edinburg Mental Wellbeing Scale (WEMWBS), the Sick Building Syndrome (SBS) questions, and single-item questions measuring productivity and job satisfaction. Actual absenteeism records were obtained of the participating sample from the organisation. Measures were taken before the participants moved into each of the green buildings and 12 months post occupancy in the green buildings. Measures of a comparison group that did not move into either of the green buildings were also taken at the same time periods. The final sample consisted of 175 participants.

The results of this study illustrated significant differences in physical wellbeing and productivity of the participants in the green building situated in Durban. Both these measures increased 12 months post occupancy in the green building. The IEQ design features that were found to most significantly impact wellbeing and productivity within the two green buildings were lighting and air conditions.

This research is important as there is a growing movement towards implementing green building design initiatives, however in order to be truly effective, the benefits of green building designs must extend beyond the benefits to the environment and also consider the benefits to its occupants (Heerwagen, 2000).

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Introduction

In the early part of the 20th century, environmental concerns, such as thermal conditions, ventilation, odours and lighting were of great importance in examining factory and early office environments. By the middle of the 20th century, environmental concerns had broadened to incorporate the effects of harsh environments such as heat stress and cold stress and noisy surroundings. Moving through the 1960s and 1970s, changes in building technologies and office design led to a renewed interest in environmental conditions, particularly in schools and offices. The mass computerisation of the modern office began around the 1980s and with this many comfort, health and performance issues associated with inadequate work environment conditions arose. Today, these same concerns remain, and as our workplaces are continuously permeated with information technologies, there is a focused attention on better understanding the effects of the work environment (Hedge, 2000).

In order for organisations to be truly effective, it is argued that they need to succeed across three levels, environmental sustainability, organisational effectiveness, and human wellbeing. It has been proposed that one of the ways this may be achieved is through the design and use of green buildings. Proponents of sustainable design argue that green building design features and strategies will enhance interior environmental quality which has a positive impact on health and productivity when compared to non-green buildings (Heerwagen, 2000).

To be able to achieve this outcome, there must be certain unique features of green building designs that contribute to a more comfortable and satisfying work environment which, in turn, affects organisational effectiveness and wellbeing (Paul & Taylor, 2008).

This study will look at the impact that green buildings have on specific organisational outcomes, such as physical and psychological wellbeing, productivity, absenteeism and job satisfaction. The linkage between green buildings and these outcomes will be examined at the organisational level of analysis as this ultimately impacts organisational performance and functioning (Currall, Towler, Judge & Kohn, 2005).

Chapter 1: Literature Review

Green Buildings

Green buildings are facilities that are designed, built, operated, renovated and disposed of using ecological principles to promote occupant health and resource efficiency. Green buildings further minimise the impact of the built environment on the natural environment. In the context of green buildings, resource efficiency takes into account the efficient usage of water and energy, the appropriate use of land, the use of environmentally friendly materials, and reducing the life cycle effects of the building's design and operation (Kibert, 2004). Green buildings can be seen as 'healthy' buildings, free of hazardous material and able to promote the health and comfort of occupants during its entire life cycle, supporting social needs as well as enhancing productivity. A healthy building recognises that occupants' health needs are priorities (Bluyssen, 2010).

Maintaining good Indoor Environmental Quality (IEQ) and comfort affects the health and productivity of employees and as a result cannot be ignored and should be considered as an integral part of sustainable development (Moschandreas & Nuanual, 2008). Green buildings are therefore proposed to be better for people due to the fact that they generate higher quality, healthier, more habitable environments as compared to conventional buildings (Heerwagen, 2000). In the context of this research, green buildings are buildings that have been designed with the explicit intent to include environmentally sustainable design features whereas conventional buildings refer to buildings where the design intent did not pay attention to environmentally sustainable design features or principles (Leaman, Thomas & Vandenberg, 2007).

There are several rating systems that exist internationally that have been established to legally certify green buildings (Moschandreas & Nuanual, 2008), including LEED from the US, BREEAM from the UK, and Green Star from Australia. In 2007, the Green Building Council of South Africa (GBCSA) was formed as an independent, non-profit organisation. The GBCSA developed Green Star SA, based on the Green Building Council of Australia's Green Star Rating System to provide a standardised measurement of green buildings in the property industry. The GBCSA is a full member of the World Green Building Council and the official

certification body of buildings under the Green Star SA Rating System. The Green Star Rating system is aimed at promoting integrated, whole-building design, raising awareness of the benefits of green buildings, reducing the impact that development has on the environment, and recognising environmental leadership. The rating system focuses on nine categories which are divided into credits.
Points are awarded in each credit for measures that exhibit that the project has met the overall objectives of Green Star SA. Based on the total number of points gained, the building project can achieve one of three levels of certification; that is a 4-Star, 5-Star, or 6-Star SA Certified Rating. The GBCSA intends to ensure that buildings are designed and operated in an environmentally sustainable way so that South Africans may work and live in healthy, effective, and productive environments (http://www.gbcsa.org.za).

The categories that are evaluated include Management, Energy, Transport, Water, Materials, Land Use and Ecology, Emissions, Innovation, and Indoor Environmental Quality (IEQ). IEQ includes aspects such as building ventilation rates, daylighting, use of electrical lighting, external views, and thermal comfort (http://www.gbcsa.org.za). This study will focus specifically on the aspects of IEQ as this category has the most direct impact on building occupants compared to the other categories. People spend approximately 80 to 90 percent of their time indoors (Steemers & Manchanda, 2010) and studies have found various comfort and health effects to be associated with building characteristics such as, ventilation and conditioning systems, and the indoor environment which impacts work performance (Hedge, 2000; Kats, 2003; Fisk, 1999; Ries, Gokhan, Needy & Lascola, 2006 & Wyon, 2003). It is therefore in the interest of organisations to provide satisfying indoor work environments to its occupants for their wellbeing and productivity (Steemers & Manchanda, 2010). Buildings can be seen as complex systems consisting of physical and human components and their many associations, interactions, interfaces and feedback (Leaman & Bordass, 1999). From the organisation's view, the quality of the workplace is an important element that can give rise to substantial direct and indirect costs. Direct costs are those such as energy and waste treatment and indirect costs are those such as lowered productivity and sick leave (Bergs, 2002).

Complaints by office workers have been on the increase since the 1970s, which was a time when new office equipment and arrangements were introduced, such as new spatial concepts (for example open-plan offices), innovative climate control equipment, new materials and computerisation. The nature and types of activities performed in offices have also changed

significantly, however buildings were not adapted accordingly. There has been a move from routine work to work tasks that demand more concentration, and that are performed with the aid of equipment that must be ergonomically integrated into the work environment (Bergs, 2002).

Wellbeing is an important factor to be considered in determining the quality of work life of employees. During the late 1980s and 1990s the World Health Organisation's (WHO) concept of health became significant for recognising the concept of a 'healthy building' in terms of building performances such as indoor air quality, lighting quality, acoustics, and thermal comfort (Bluyssen, 2010).

Many international standards are moving towards people-centric regulations and guidelines for building design, realising that previous design strategies may have neglected significant psychological, cultural, and social dimensions (Steemers & Manchanda, 2010). This strategy has an enhanced public interest and integrates wellbeing and wellness activities into the responsibility of the employer with the aim of maximizing staff potential, reducing absenteeism due to illnesses, and retaining staff for longer time periods with greater job satisfaction as they feel valued by the organisation (Hillier, Fewell, Cann & Shepard, 2005). In this way managers attempt to create conditions which bring out the best in people as well as add value to business investments and services (Leaman & Bordass, 1999). Green buildings therefore should not be seen only as an environmentally responsible alternative but also as a smart, financially responsible business strategy (Von Paumgartten, 2003). Green building includes strategies that are aimed to create and sustain healthy, comfortable indoor environments (Pyke, McMahon & Dietsche, 2010). It is argued that sustainable building design will become increasingly common practice once the human benefits are identified; mainly the increase in employee productivity believed to be associated with the provision of high quality indoor environments (Heerwagen, 2000). The benefits of green buildings include certain elements that are relatively easy to quantify, such as water and energy consumption, as well as elements that are not as easy to measure such as improved IEQ (Kats, 2003).

Organisational Outcomes

This section discusses the literature findings related to IEQ conditions and its impact on psychological wellbeing, physical wellbeing, productivity, job satisfaction and absenteeism.

A brief introduction to each of the organisational outcomes is provided and is subsequently discussed in detail throughout this section.

Physical and Psychological Wellbeing

Physical wellbeing refers to the actual physical health of employees. Psychological wellbeing refers to the mental, psychological or emotional aspects experienced by employees (Danna & Griffin, 1999). The wellbeing of employees is in the best interests of both organisations as well as communities. The workplace is a major part of an individual's life that affects their work-life and the wellbeing of the communities with which a person interacts. The average adult spends as much as a quarter to a third of their waking life working (Harter, Schmidt & Keyes, 2002). As much as a fifth to a quarter of the variation in adult life satisfaction can be accounted for by their satisfaction with work (Harter et al., 2002).

Health and wellbeing matters are important due to their consequences for employees and organisations, as they can both potentially be affected in a negative manner (Danna & Griffin, 1999). For example, employees experiencing poor health and wellbeing in the workplace may be less productive and may be more prone to be absent from work, diminishing their overall contributions to the organisation. For the individual, physiological, psychological, and/or emotional consequences may also surface (Danna & Griffin, 1999).

The quality of life of individuals and their work performance stems from the behavioural, cognitive and health benefits of positive feelings and positive perceptions experienced. The presence of positive emotional states and the positive appraisal of the work environment enhance work performance and quality of life in general (Harter et al., 2002). In this study, both physical and psychological wellbeing and their relation with IEQ conditions are investigated.

Productivity

The nuances of work make the notion of productivity complex in humans as they are affected by mental, motivational, emotional and social influences. Such influences can affect production in ways comparable to physical injury or malfunction. Therefore it is often difficult to describe productivity in concise terms and what should be done to optimise it. It cannot simply be reduced to accounting measures or presence on the job or amount of work output, even though these are important factors (Hillier et al., 2005). Productivity can be

defined as the output of any process, per unit of input. Therefore it relates directly to the performance of the process elements, including the employees (Ries et al., 2006). Leaman and Bordass (1999) define productivity as "the ability of people to enhance their work output through increases in the quantity and/or quality of the product or service they deliver" (p.6).

Job Satisfaction

Scarpello and Campbell (1983) argue that it can be assumed that overall job satisfaction is a function of the person-environment interaction. Therefore employees will be more satisfied when they enjoy the environment in which they work. That is, the manner in which employees experience the environment will also impact on job satisfaction.

Absenteeism

Sick leave is of interest to organisations because it impacts significantly on its operating costs (Sustainability Victoria & Kador Group, 2006). Absenteeism due to illness is the number of days spent away from work with the specified reason being sick leave. The primary cost associated with sick leave is in the form of lost salaries as a result of paid leave, and further costs include hiring temporary staff to replace those on leave if required (Sustainability Victoria & Kador Group, 2006). Employees with adverse health conditions are absent more often, lose more work hours and tend to be less productive than employees without these conditions. Green building attempts to address IEQ and employee health concerns by providing healthier building environments (Singh et al, 2010).

IEQ Conditions and Organisational Outcomes

The relationship between IEQ conditions and wellbeing, productivity, job satisfaction and absenteeism are investigated in this study. Research findings associated with IEQ and these organisational outcomes are further discussed below.

Heerwagen (2000) mentions common green building design features that influence IEQ. These include advanced ventilation systems, building materials and furnishings with low toxicity, increased use of natural daylight, high quality lighting which reduces computer glare, and external views that increase contact with the natural environment. Benefits related to these "green" features include enhanced employee productivity, health and wellbeing, job satisfaction, and decreases in absenteeism (Kats, 2003).

A primary aim of sustainable design is that it attempts to maximize occupant comfort and satisfaction, while minimising the environmental impact and costs. IEQ is the commonly used term to describe the building features that directly impact occupant satisfaction. The IEQ of a workplace considers the interaction of air, lighting, and surroundings with occupants in a holistic sense (Fowler & Rauch, 2008). Indoor air quality has been shown to correlate with both physical and psychological wellbeing (Hedge, 2000). As a result IEQ effects include occupant health, productivity, and satisfaction (Fowler & Rauch, 2008).

The effect of IEQ in office buildings on employee health, wellbeing and productivity is a topic of concern as IEQ can have a negative impact on employees' physical health through poor air quality, extreme temperatures, and insufficient ventilation. Green buildings attempt to address IEQ and employee health concerns by providing healthier and more satisfying working environments (Singh, Syal, Grady & Korkmaz, 2010). Hillier et al. (2005) argued that the workplace is a key setting through which employee health can be improved, and that effective management of health risks will help maximize the wellbeing and productivity of employees, as well as improve the organisation's reputation with customers, competitors, suppliers, other stakeholders, and the broader community.

Research areas investigating relations between the physical work environment, the individual workers, and the organisation are commonly found. However, the literature remains scattered and poorly linked to the engineering and design principles. Designers and facilities managers continue to ask for demonstrable proof that the physical environment influences organisational outcomes such as job satisfaction, absenteeism, turnover, and, ultimately, organisational productivity. Business managers often view the physical office environment as simply a convenient space to house their employees, rather than an asset that could positively influence their staff. The physical conditions and the personal workspace however, jointly determine satisfaction with features of the physical environment, which in turn positively predict overall environmental satisfaction as well as job satisfaction (Veitch, Charles, Farley & Newsham, 2007). According to Leaman and Bordass (1999) losses (or gains) of up to 15% of turnover in an organisation may be attributable to the design, management and utilisation of the indoor environment. The actual figures are difficult to ascertain. However, there is consensus that the indoor environment can improve output, and furthermore can be

associated with related factors such as perceived health, comfort and satisfaction (Leaman & Bordass, 1999).

Riedel et al. (2001, as cited in Hillier et al., 2005) examined how organisations allocate their money and services to keep its human capital functioning optimally. They found that certain resources can be assigned to quantifiable expenditures such as maintenance and repairs, however they also identified the loss of potential revenues as a result of sub-par performance. "When machines are monitored, financial costs and losses are known and fairly well documented. When human beings are monitored, however, we know more about costs than losses (salary, on costs, work resources, space and other utilities, etc.)" (Hillier et al., 2005, p.423).

It is difficult to measure productivity or work output meaningfully for all building occupants as it is not easy to compare the productivity of employees working at different organisational levels and working in different jobs. For example, what is an accurate way of comparing the productivity of a call centre agent with their managers? (Leaman & Bordass, 1999). Similarly comparing the productivity of an office clerk is different to that of an accountant which is different to the productivity of a Chief Financial Officer. One method of doing this, which was utilised in the Leaman and Bordass (1999) study, is to use scales that measure perceived productivity of employees as opposed to measuring their productivity directly (Leaman & Bordass, 1999). This method however is limited in that it relies on the employees' report of their perception of productivity which may not necessarily be a true reflection of their actual productivity. Furthermore, the reference point that employees may use to judge their own productivity may be different and contextual factors may also affect their judgements, for example rumours of possible redundancies within the office environment (Leaman & Bordass, 1999).

There is no established standard for measuring the precise productivity impact of a conventional building or of a green building. Green buildings do not possess an identical set of technologies and design attributes to the same degree and therefore they will have differing effects on productivity outcomes. However, ventilation, thermal conditions and daylighting have been shown to be positively correlated with increased productivity (Kats, 2003). Wyon (2000) also states that indoor air quality and air temperature have significant effects on the efficiency with which work can be performed. Green buildings incorporate more natural

ventilation or a combination of natural ventilation and air conditioning resulting in the circulation of increased fresh air by means of the mechanical ventilation system (Leaman et al., 2007). These more efficient rates of air filtration, increased ventilation and reduction in air re-circulation, reduce the risk of spreading airborne bacteria and virus molecules. A study by Liton et al. (1998, as cited in Fisk, 1999) found that absence rates of employees were lower in high ventilation buildings when compared to normally ventilated buildings.

Exposure to indoor air pollutants such as carbon monoxide can impair performance. Poor indoor air quality in office buildings has been associated with illness symptoms and reduced productivity. This may be caused by different contaminants such as combustion gases, volatile organic compounds, and microbiological organisms such as bacteria. Many aspects encountered daily in everyday office work can potentially cause indoor air quality problems (Hedge, 2000).

The thermal environment also directly affects employee productivity (Wyon, 2000). Thermal comfort as defined by ASHRAE (1966) is "that condition of mind which expresses satisfaction with the thermal environment" (Parsons, 2000, p.585). The reference to 'mind' shows that it is largely a subjective term, however there are indices that can be used to assess environments for thermal comfort (Parsons, 2000). The key variables in thermal comfort are temperature and humidity. Thermal comfort is a critical objective that green buildings need to deliver (Sustainability Victoria & Kador Group, 2006). Evidence has been found linking the thermal environment, predominantly air temperature, with productivity for a wide range of temperatures most commonly experienced in buildings. The optimum temperature for task performance varies according to the nature of the task and individual differences. As a result it has been suggested that it may be better for individuals to be given personal control over managing their thermal environment (Fisk, 1999).

A study by Paul and Taylor (2008) confirmed that thermal comfort influences overall satisfaction with the workplace environment. Occupants who felt warm in their environments were more likely to rate their work environment as poor and those who felt cool were more likely to rate it as average. Occupants who were thermally comfortable were more likely to rate their work environment as good. Their study looked at thermal comfort in university buildings. However, it suggests that the connection between thermal comfort and workplace satisfaction is likely to be true of other types of office buildings, conventional or otherwise,

where most of the occupants are involved in work that is mostly computer-based (Paul & Taylor, 2008). This study by Paul and Taylor (2008) was conducted in an Australian work environment where it is seldom very cold, similar to the South African climate.

A report by Miller, Pogue, Gough and Davis (2009) based on a survey of more than 500 occupants in green buildings showed that temperature matters and influences productivity, reporting the highest productivity at a temperature of around 22 degrees Celsius. They also reported a direct relationship between the percentage of occupants who are dissatisfied with indoor air quality and the measured decrease in performance.

Research conducted by Lan, Wargocki, Wyon and Lian (2011) on participants placed in two significantly different thermal comfort environments of 22 and 30 degrees Celsius showed an increase in the intensity of Sick Building Syndrome (SBS) symptoms sleepiness, fatigue, headache and dry, irritated eyes. Whilst participants performed work simulated tasks assigned to them in the warmer condition (30 degrees), their performance decreased compared to when they were thermally neutral at 22 degrees. This shows that discomfort increases in warmer temperatures and has a negative impact on health and performance. These two conditions were selected as Niemla, Seppanen, Korhonen and Reijula (2006) suggested that a temperature of 22 degrees creates conditions for optimal performance while at a raised temperature of 30 degrees, performance should be considerably reduced (Lan et al. 2011).

Ventilation as defined by Menzies and Bourbeau (1997) is the amount of outdoor air supplied to the indoor environment. Heerwagen (2000) argues that enhancing indoor air quality can affect an organisation's bottom line by reducing absenteeism and health care costs.
Case studies conducted by the Victoria and Kador Group (2006) revealed a 39% decline in absenteeism rates of employees that were monitored before moving into a green building and a nine month period after the move. A further study reported by Fisk (1999) considered ventilation rates of buildings and showed that absenteeism rates were 34% lower in better ventilated buildings which decrease indoor concentrations of pollutants.

Health related issues can be associated with lower employee productivity (Ries et al., 2006). Health problems can affect employee productivity directly in the work area or indirectly by leading to absenteeism. Direct effects on employee health on productivity can be seen as employee discomfort experienced by allergies, drowsiness and similar symptoms related to

health issues caused by poor indoor air quality. These types of symptoms that cause discomfort may reduce productivity (Ries et al., 2006). Green buildings address a combination of measures that help reduce the pollutants that cause illness through IEQ aspects and therefore can be seen as providing improved productivity and health benefits which in turn reduce absenteeism, when compared to non-green buildings (Kats, 2003).

Two Dutch studies, as cited in Bergs (2002), revealed that a sizable proportion of sick leave can be attributed to the quality of the workplace environment. The Preller report (1990) as cited in Bergs (2002) indicated that between 25% and 30% of total absences can be attributed to building-related health complaints by employees. The Schermer report (1992) as cited in Bergs (2002) showed that about half of all employees take sick leave days because of such complaints. A further study by Bergs (2002) reported that a healthy indoor climate can result in a decrease of 2.5% in employee absenteeism.

The level and severity of hazards occurring in office environments is lower than in manufacturing, mining and construction industries, and the assumption that is then often made is that office work is clean and safe. However, the office environment is not without health risks (Klitzman & Stellman, 1989). Indoor air pollution and ventilation problems in offices, for example, have been associated with various respiratory, visual and dermatological complaints. Physical characteristics of the work station such as screen displays, lighting, glare and position of the work surface have been related to musculoskeletal and visual strain among workers (Klitzman & Stellman, 1989).

Modern buildings tend to be designed in such a way that they are often sealed from the outdoors. This reduces natural ventilation and increases the potential for illnesses (Knowles et al., 2002). Research on health in buildings has focused on SBS and its relationship to IEQ. SBS can negatively impact an organisation especially when symptoms are related to reduced work performance or absenteeism. Improved air quality, a feature of green buildings, has been shown to reduce illness and absenteeism associated with SBS (Heerwagen, 2000). Due to the fact that SBS symptoms typically appear while at work and disappear when not at work, symptoms are considered to be "caused" by exposure to something in the office building (Hedge, Erikson & Rubin, 1996). SBS symptoms most commonly found include irritation of the eyes, nose, and skin, headaches, fatigue and difficulties in breathing. Building features suspected to influence these symptoms are ventilation systems, levels of chemical

and microbiological pollution, and indoor temperature. Therefore, SBS symptoms are distinctly linked to features of buildings and indoor environments. Improving indoor environments should, as a result, reduce SBS symptoms (Fisk, 1999).

Burge (2012) describes general and mucous membrane symptoms commonly associated with SBS. A general feeling of tiredness and lethargy is usually the most prevalent symptom which often starts within a few hours of arriving at work, and improves within minutes after leaving the building. The typical headache is non-migrainous, rarely throbbing, mostly described as a dull pressure on the head. The most commonly experienced symptom is a blocked or stuffy nose. Furthermore, dryness of the throat, perhaps associated with increased thirst, as well as dry eyes are predominantly experienced. In addition to these, dryness of the skin is also experienced.

The economic consequences of SBS relate to the decreased productivity due to the conditions of the working environment, the costs of labour, and the costs of providing the environment. These factors vary widely in different countries and environments (Burge, 2012). Raw (1990, as cited in Burge, 2012) examined the costs of sick building syndrome in a large government office with 2500 employees, assuming one day's sickness absence per year attributed to sick building syndrome and one hour per month dealing with or complaining about the indoor environment. At 1990 prices at that particular time, the costs to the organisation were £400 000 for one year. Employees who are unable to adjust environments which they find unsatisfactory are more likely to develop sick building syndrome. Their inability to improve their environment can be seen as a source of stress which can increase their symptoms, and perhaps lead to their reduced productivity. The employees in a building are "its most expensive commodity; looking after their environment as well as that needed for the mainframe computer is likely to be cost effective" (Burge, 2012, p.189). Therefore it is not only important for organisations to provide and maintain the equipment and systems necessary for workers to perform their jobs but also to provide comfortable working environmental conditions to enable this to happen (Burge, 2012).

A study by Niemela et al. (2006) looked at the association between the prevalence of SBS symptoms and productivity of employees in a call centre and insurance office environments. They found that in poor IEQ environments 'irritating' symptoms due to the air contaminants were more likely to be linked with short-term absences of employees. In the case of poor IEQ

a single employee may have limited opportunities, if any, to reduce concentrations of air contaminants while in the case of thermal discomfort, he or she may change for instance clothing or adjust the room temperature to improve thermal climate. It is suggested that the productivity change due to reduced employee performance is more likely to be associated with the general symptoms such as fatigue and headache, usually because of thermal discomfort rather than the irritation symptoms in eyes or the respiratory tract primarily due to air contaminants. Specifically, the data from the call centre indicated that an average reduction of 10% in the prevalence of weekly occurring general symptoms were associated with a 1.5% increase in productivity. The data from the insurance company revealed that an average reduction of 10% in the prevalence of weekly irritation symptoms related to a 0.7% decrease of short term absenteeism rate.

SBS symptoms hinder work performance and can cause absences from work and increased visits to doctors. In a review of the literature on SBS and productivity, Fisk (2000) argued that SBS can cause on average a 2% decrease in employee productivity, which equates to an annual nationwide cost of 60 billion U.S. dollars. The existing evidence suggests that significant reductions in SBS symptoms, of approximately 20% to 50%, should be possible through improvements in indoor environmental conditions (Fisk, 2000). Psychological wellbeing can be negatively affected through inadequate lighting, poor acoustics, and poor ergonomic design. Employees with such adverse health conditions tend to be absent more often and are less productive than employees who do not suffer with these conditions (Singh et al., 2010).

Aspects of the physical environment can pose potential problems not only to physical wellbeing of employees but also their psychological wellbeing. Physical characteristics such as temperature and ventilation, lighting and work station design have been associated with employee attitudes and behaviour, particularly comfort, satisfaction and turnover. These are not direct measures of health however these responses play an intermediate role in the stress-health process and employees who are dissatisfied with the workplace are more likely to experience more health problems than satisfied employees (Klitzman & Stellman, 1989).

A study by Klitzman and Stellman (1989) found that the physical aspects of the work environment can have an impact on psychological wellbeing. They found that physical environment characteristics had a stronger influence on office satisfaction than on symptoms

of psychological distress, while psycho-social working conditions were more strongly correlated with job satisfaction. Their study revealed that noise and air quality were two of the strongest predictors of psychological wellbeing.

Work is a pervasive and influential part of employee wellbeing. It affects their quality of life and mental health and as a result affects work performance. The ability therefore to promote wellbeing rather than engender strains and mental illness can benefit employees and the organisation's bottom line (Harter et al., 2002).

Another aspect of IEQ, lighting has further effects on occupant health in buildings (Heerwagen, 2000). Lighting has the potential to influence performance directly because work performance depends on vision, as well as indirectly because lighting may direct attention, or influence arousal or motivation (Fisk, 2000). Aspects of lighting such as light intensity, glare and the spectrum of light are associated with health and performance (Fisk, 1999). Comfortable lighting does not cause blinding, flickering or glare on computer screens and creates a good colour impression, no reflections and an equal distribution of light. This can be achieved through consideration of the position and intensity of lighting systems, surface area treatment and use of different types of screens (Bluyssen, 2010). Poor lighting can lead to health problems, therefore, striving to create healthy luminous indoor environments can be used in an effort to prevent these potential problems (Begemann, Van Den Beld & Temmer, 1997). Eyestrain can also be caused by inadequate lighting conditions. Too little or too much light, obscuring reflections, glare and flicker can all lead to strain on the eyes. This causes irritation in the eyes which can lead to a breakdown of vision and cause headaches (Parsons, 2000). Furthermore, additional light makes it easier to see visual tasks and more light will improve performance, in turn, improving productivity (Leslie, 2003).

Lee and Kim (2008) conducted a study comparing features of green and conventional buildings. Their findings showed that lighting quality seemed dissatisfactory in the green buildings due to personal workspaces being too dark and due to there being no provision for task lighting. Some of the participants from the green buildings felt that there was not enough daylight whereas others felt that there was not enough electric lighting, which indicated that overall there was not enough lighting in their personal workspaces. Therefore improving lighting quality for individual workspaces should be taken into account to improve issues of satisfaction and task performance of office employees (Lee & Kim, 2008).

A study by Mills, Tomkins and Sclangen (2007) was conducted where the installation of fluorescent lighting in a shift-working call centre was implemented to determine the effects of lighting on the employees. They found that better lighting contributed to wide ranging improvements in wellbeing, functioning and work performance amongst those who participated in the study. The lighting adjustments were well received by the employees and can be seen to be a cost-effective means of impacting on employee wellbeing and productivity.

Glare from electric lights, particularly on computer screens, has been associated with health related issues such as headaches, muscular problems and strain on the eyes (Heerwagen, 2000). To reduce glare, the use of flat screens or antiglare devices have been proposed. Care should also be taken to position the display in a manner in which light sources will not create glare (Hedge, 2008).

In general, the main purpose of indoor lighting has been to assist employees with visually directed tasks where there is insufficient external light. However, lighting is not only important in completing tasks but it can also have strong non-visual biological effects impacting on employee mood and alertness (Mills et al., 2007). Mills et al. (2007) suggested that the relative shortage of daylight exposure for office workers during daily life may compromise their health and wellbeing, which is the reason for the stimulated interest in the applications of light in the office environment. Of particular relevance is the fact that whilst outdoor illuminance typically ranges between 2000 and 100,000 lux, indoor office illuminance is mostly significantly lower, with norms of approximately 500 lux. Furthermore, typical fluorescent indoor lighting contains much less short wavelength "blue spectrum" light than does natural daylight, which is the specific component of the spectrum thought to be highly relevant for achieving non-visual, biological effects (Mills et al., 2007).

Green buildings do not only consider electric lighting but also aim to incorporate daylight and external views as further key features of IEQ. Daylighting is the design of buildings using light from the sun. When done properly, an interior environment supportive of human health and activities can be created. If done improperly, it can impede vision, cause discomfort and use excessive energy (Leslie, 2003). Daylighting has been supported as a means of reducing lighting energy used in buildings. By making sufficient use of available daylight,

considerable energy costs can be saved by reducing the amount of electric lighting used (Heschong, Wright & Okura, 2002). Heschong et al. (2002) looked at the effects of daylighting in schools and found that benefits included improved vision, health and morale of students. These findings can be generalised to adults occupying buildings and therefore daylighting may also positively impact performance. Studies conducted in office buildings have found that people value daylight and prefer to be situated next to or near windows (Heerwagen, 2000).

Daylight offers features that electric lighting systems do not, such as access to window views. Views allow occupants to obtain visual information about the weather, time and day, as well as surrounding activities (Leslie, 2003). Nature plays an important role in health and wellbeing. Having views to nature is an effective means of relieving stress and improving wellbeing (Heerwagen & Hase, 2001). Access to nature in the workplace is associated with lower levels of perceived job stress and increased levels of job satisfaction. Occupants with a view of a natural setting such as trees and flowers felt less stress and more job satisfaction than those who could only see built environments from their windows. Those with views of nature also reported fewer illnesses and headaches. Furthermore, observing nature can restore concentration and improve productivity (Maller, Townsend, Pryor, Brown & St Leger, 2005).

Studies have shown that incorporating the natural environment into buildings can have a positive influence on psychological and physical wellbeing. Urban settings, even though they do not have expansive natural landscapes, can still provide beneficial nature contact through indoor plantings, small-scale outdoor sitting areas with trees, and décor containing themes of nature (Heerwagen & Hase, 2001).

Job satisfaction in relation to IEQ considers the manner in which occupants experience the work environment which influences their job satisfaction (Scarpello & Campbell, 1983). A study by Oldham and Rotchford (1983) found that office characteristics, including office darkness, affect employee reactions through their influence on employees' experiences with the office environment itself. When taking into account green design features, elements of the physical workspace clearly come into play. Lighting, ventilation and thermal comfort play an integral part in defining the IEQ. Von Paumgartten (2003) cites a study from the Buffalo Organisation for Social and Technological Innovation which showed that the physical workplace affects job satisfaction by as much as 24%. A study by Steemers and Manchanda

(2010) looked at factors that influence occupant satisfaction within buildings. Their findings revealed that IEQ aspects such as air quality, lighting and temperature were linked to the occupants' job satisfaction and their overall satisfaction and comfort. Furthermore, they report that low energy-consumption design can achieve occupant satisfaction and that satisfaction in turn is associated with physical health.

The literature discussed shows that productivity can be enhanced by improving the indoor environment in a manner that reduces illness and health symptoms, as well as improvements in characteristics such as thermal conditions, ventilation and lighting (Fisk, 1999). A study by Ries et al. (2006) looking at the pre and post occupancy evaluations of employees in green buildings indicated that employees agreed that the IEQ of the green building superseded that of the conventional building. They also showed that worker productivity was enhanced with views to the outdoors, the relative humidity and the temperature (Ries et al., 2006). Heerwagen (2000) states that although there are mixed results on the impact of lighting on productivity, the specific system used may not be important but rather the overall design and the actual lighting conditions that are created within the workplace through the incorporation of electric and daylight, placement of computers and the use of antiglare screens.

In most non-industrial workplaces, the costs of salaries and benefits is greater than energy costs, maintenance, and yearly construction costs or rent, by approximately a factor of 100. As a result, demonstrated and quantified improvements in health and productivity from better indoor environments could considerably change attitudes and practices related to building design and operation. Organisations should be strongly motivated to invest in many changes to building designs or building operation if these changes improved worker performance by even a significant fraction of a percent or reduced absence from work by a day or more per year (Fisk, 2000).

Literature findings show that there are many factors that can make up a working environment, including noise, light, temperature and particulates in the air. The effects of these factors on employees occupying these environments need to be considered in terms of their health, comfort and performance (Parsons, 2000). "The effects of 'total' environments include the sum of the physiological, psychological and social sensations experienced by people in or around buildings which follow from their use of the buildings." (Manning, 1968 as cited in Parsons, 2000, p. 591).

The relentless trend of how buildings should be used is a movement towards intensification and diversification with greater attention paid to the risk or value payoffs not only in terms of rental or property investment as was the case in the past, but also in terms of human and environmental resources (Leaman & Bordass, 1999). Humans are consuming resources at an unsustainable rate that is increasing as the population grows. The majority of the inefficient and sometimes reckless use of resources occurs in urban settings (Moschandreas & Nuanual, 2008). It is generally recognised that buildings consume a large portion of water, energy and other resources consumed in the economy (Kats, 2003). As a result, business benefits and these consequential environmental dis-benefits have to be managed effectively in aiming to achieve overall performance improvement. Buildings design strategies are far more closely linked to business missions to help improve the organisation's strategic advantage in the market place (Leaman & Bordass, 1999).

In summary, the implications of IEQ features can be used to increase productivity, reduce absenteeism and promote overall job satisfaction and employee wellbeing by creating satisfying work environments. This can be achieved through IEQ aspects that reduce factors associated with SBS, improving indoor air quality and thermal comfort, as well as increasing access to daylight and window views with natural settings (Heerwagen, 2000).

The built environment as a result plays a central role in physical and psychological wellbeing. Consequently, a growing body of research has illustrated the potential human resource benefits that can be achieved from green buildings (Pyke et al., 2010). Green buildings have the potential to provide cost reduction benefits by decreasing energy use, and also value-added benefits such as enhancing employee wellbeing. The focus however tends to concentrate on costs as opposed to value-added benefits (Heerwagen, 2000). The reason for this may be that cost reduction benefits such as energy and water savings can be predicted with reasonable accuracy, whereas value-added benefits such as improved health and wellbeing are a lot less precisely understood and more difficult to accurately predict (Kats, 2003). This imbalance hinders efforts made to establish evidence-based responses that may improve green building guidelines and help advance green building practice (Pyke et al., 2010). This is partly due to the complex nature of human health and performance issues and measurements, and the varying range in which human reactions to IEQ changes differ (Kats,

2003). As a result a more balanced foundation of information on building performance reflecting both people and the environment is needed (Pyke et al., 2010).

Buildings used in the study

There are various aspects that are considered in determining how "green" a building is, and the GBCSA rating system (Green Star SA) assesses buildings on nine different categories; Management, IEQ, Transport, Water, Materials, Land Use and Ecology, Emissions, Energy and Innovation. Points are awarded within each category based on the buildings potential to minimise its environmental impact in a variety of areas. Once all the categories are scored and totalled, the buildings may achieve three possible rating outcomes, either a four-star, five-star, or six-star Green Star South African Certified Rating (http://www.gbcsa.co.za). The higher certification level reflects a more environmentally-friendly and sustainable building design (Abair, 2008). It can therefore be seen in the literature that "green" buildings are often grouped together under a single unit which takes into account many different categories, of which IEQ is only one aspect. Therefore a building can potentially be rated as "green" without much consideration or emphasis being placed on the IEQ design features. Furthermore, different building designs will focus on different IEQ elements, which may result in differing impacts on organisational outcomes.

This study investigated green building design features and occupant wellbeing within two green buildings, located in Johannesburg and Durban, and investigates the claims of improved wellbeing for occupants of green buildings. The two buildings that will be investigated belong to a large financial institution, namely the Nedbank Head Office Phase II located in Sandton, Johannesburg, and the second building is Nedbank Ridgeside situated in Umhlanga, Durban. Each building has been rated as to how "green" it is according to the Green Star SA rating categories. Both the buildings have received a four-star certified rating but with slightly different emphases on IEQ elements. The focus of the study will concentrate on the IEQ aspects of the buildings and therefore the ratings achieved within this category will be considered when comparing the impact of the environments on the organisational outcomes. The IEQ component of the rating is worth a total of 27 points and the two buildings have not scored equally on this component.

The IEQ category of the scorecard has the following sub-categories; Ventilation Rates, Air Change Effectiveness, Carbon Dioxide Monitoring and Control, Daylight, Daylight Glare Control, High Frequency Ballasts, Electric Lighting Levels, External Views, Thermal Comfort, Individual Comfort Control, Hazardous Materials, Internal Noise Levels, Volatile Organic Compounds, Formaldehyde Minimisation, Mould Prevention, Tenant Exhaust Riser and Environmental Tobacco Smoke (ETS) Avoidance. The scope of this study however will look particularly at the categories listed in bold in the table below as these credits were deemed to relate directly to the organisational outcomes. These eight sub-categories focus on the IEQ aspects discussed in the literature and are the aspects focused on in this study.
The number of points available and the actual points that each building received are detailed in Table 1 below:

Table 1: IEQ Component of the Scorecard for each Green Building:

IEQ Features	***Points Available***	***Phase II Points Achieved***	***Ridgeside Points Achieved***
Ventilation Rates	**3**	**2**	**3**
Air Change Effectiveness	**2**	**2**	**2**
Carbon Dioxide Monitoring and Control	1	1	1
Daylight	**3**	**0**	**1**
Daylight Glare Control	**1**	**0**	**1**
High Frequency Ballasts	**1**	**1**	**1**
Electric Lighting Levels	**1**	**1**	**0**
External Views	**2**	**2**	**1**
Thermal Comfort	**2**	**0**	**0**
Individual Comfort Control	2	0	0
Hazardous Materials	0	N/A	N/A
Internal Noise Levels	2	2	2
Volatile Organic Compounds	3	1	1
Formaldehyde Minimisation	1	1	1
Mould Prevention	1	0	0

Tenant Exhaust Riser	1	0	1
Environmental Tobacco smoke (ETS) Avoidance	1	1	1
Total Points	27	14	16

The GBCSA outlines the intentions of each of the sub-categories as per the scorecard; Ventilation rates encourage and recognise designs that provide ample amounts of outside air to counteract build-up of indoor pollutants. Air change effectiveness recognises systems that effectively deliver optimum air quality to any occupant throughout the occupied area. Daylight assesses designs that provide good levels of daylight for building users. Glare control considers designs that reduce the discomfort of glare form natural light. High frequency ballasts recognise the increase in workplace amenity by avoiding low frequency flicker that may be associated with fluorescent lighting. Electric lighting levels measure base building provided office lighting that is not over designed. External views determine the extent of the designs that provide occupants with a visual connection to the external environment. Lastly, thermal comfort assesses buildings in their level of thermal comfort achieved.

These aspects account for 15 out of the 27 points for the IEQ section of the rating system. Both buildings achieved the highest possible score for air change effectives and high frequency ballasts and each building scored zero points for thermal comfort. Overall Ridgeside scored slightly higher than Phase II, with Ridgeside scoring 9 points and Phase II scoring 8 points on these particular IEQ sections. Ridgeside scored higher on ventilation, daylight and glare control. Phase II did however score higher on electric lighting levels and external views. This study will therefore take these differences into consideration in determining whether or not the differences among the IEQ aspects actually have differing influences on the organisational outcomes.

This study will investigate the value-added benefits of green buildings on organisational outcomes such as physical and psychological wellbeing, job satisfaction, absenteeism and productivity. Post Occupancy Evaluations (POE), based on self-report measures completed by the building occupants, have been conducted in order to understand how the green buildings are performing and how satisfied the occupants are with the environment that has been created (Hewitt, Higgins, Heatherly & Turner, 2005).

Research questions:

1. Is there a difference in employee wellbeing (physical and psychological), job satisfaction, absenteeism and productivity in employees before moving into their respective green buildings, and 12 months post-occupancy in each of the green buildings?
2. Which of the IEQ design features of the green buildings influence wellbeing and productivity?
3. Do these design features differ within the two buildings and subsequently have differing influences on organisational outcomes?

Chapter 2: Methodology

Research Design

This is a quantitative, non-experimental, longitudinal research design (Welman, Kruger & Mitchell, 2005). The research was conducted on existing data that had already been collected as part of a larger study. This data was collected from employees within a large financial institution and utilised for the purpose of this specific study.

Participants

The participants of this study were from a large financial institution. The sample consisted of participants located in offices in Johannesburg (Phase II) and Durban (Ridgeside). Self-report measures of the participants were taken of the two groups before they moved into their respective green buildings at Time 1. The same self-report measures were then taken again 12 months later, at Time 2 for both the groups. The same measures were also taken for a group of employees who did not move to the green buildings and remained in the conventional building. Those participants who responded at Time 1 were matched to Time 2 by employee number.

At Time 1 there were 609 completed responses returned for Phase II and 298 returned at Time 2. The number of respondents matched at Time 1 and Time 2 in the Johannesburg building was a total of 134 participants. Of these participants, 84 of them were in the green building at Time 2 and 50 of them remained in the conventional building. At Time 1 there were 205 completed responses returned for Ridgside and a total of 110 responses at Time 2. The total number of respondents matched at Time 1 and Time 2 in the building situated in Durban was 41. From this group, 27 of them were in the green building at Time 2 and 14 of them remained in the conventional building. The composition of the final samples in each of the buildings in terms of gender, race and age is described in Table 2.

Table 2: Biographical Details of the Sample

	Phase II Moved to Green Building (N=84)	***Phase II Conventional Building (N=50)***	***Total Percentage Phase II***	***Ridgeside Moved to Green Building (N=27)***	***Ridgeside Conventional Building (N=14)***	***Total Percentage Ridgeside***
Gender						
Male	26	24	37.3	8	3	26.8
Female	58	26	62.7	19	11	73.2
Race						
African	10	8	13.4	0	1	2.4
White	58	28	64.2	17	2	46.4
Coloured	5	6	8.2	0	3	7.3
Indian	10	8	13.4	9	8	41.5
Other	1	0	0.8	1	0	2.4
Average age of occupants (years)	41.3	42.5		42.4	39.1	

Non-probability, convenience sampling was used to collect the data and employees could choose whether or not to complete the self-report measures. The sample sizes after matching the employees at Time 1 and Time 2 were relatively small, particularly for the Ridgeside buildings. However given that the matched design was better suited to this specific research study as it provided a more direct measure on the differences being examined, the data analyses were run on the samples obtained. The differences on the measures between Time 1 and Time 2 provide more focused measurements than would non-matched samples.

Measures

Data was collected by means of self-report questionnaires measuring psychological and physical wellbeing as well as perceptions of physical work conditions.

Psychological Wellbeing

The Warwick-Edinburg Mental Well-Being Scale (WEMWBS) was used to measure psychological wellbeing. WEMWBS is a 14 item scale of mental well-being covering subjective wellbeing and psychological functioning. Each item of the scale is answered on a 5-point scale ranging from (1) 'none of the time' to (5) 'all of the time'. Sample items included questions such as, "I've been feeling optimistic about the future" and "I've been dealing with problems well". Stewart-Brown and Janmohamed (2006) reported a Cronbach's alpha coefficient of 0.89 for the scale, based on a student sample size of 348. They also reported a Cronbach's alpha coefficient of 0.91 for a general population sample of 1749 people. In this study the Cronbach alpha for the scale for the participants in the Johannesburg buildings was 0.94 for those who moved to the green building and 0.90 for those who remained in the conventional building. The Cronbach alpha for the sample for the participants in the Durban buildings was 0.95 for those who moved to the green building and 0.93 for those who remained in the conventional building.

Physical Wellbeing

Physical wellbeing was assessed using the Sick Building Syndrome (SBS) questions, developed by Hedge et al. (1996). There were 15 items that were utilised to ascertain the employees' physical symptoms, of SBS, experienced whilst at work during the last month. Items asked participants in the past month how often they experienced physical symptoms at work such as tiredness or lethargy. The items were scored on a scale ranging from (1) never (2) 1-3 times/ month (3) 1-3 times/week and (4) Everyday. All 15 items are reverse scored. Cronbach alpha analyses conducted on the SBS questions revealed a Cronbach alpha for the scale for the participants in the Johannesburg buildings was 0.82 for those who moved to the green building and 0.86 for those who remained in the conventional building. The Cronbach alpha for the sample for the participants in the Durban buildings was 0.86 for those who moved to the green building and 0.87 for those who remained in the conventional building.

The questionnaire also included 14 items on employees' perception of the physical environment, developed by Hedge et al (1996). Items assessing the physical work environment asked participants in the past month how often they have experienced the office conditions as too warm or too drafty, for example. The items were again scored on a scale ranging from (1) never (2) 1-3 times/ month (3) 1-3 times/week and (4) Everyday. All 14 items measuring perceptions of the physical environment are reverse scored. The Cronbach

alpha for the 14 items measuring the perceptions of the physical environment was 0.76 for Phase II and 0.77 for Ridgeside.

Job Satisfaction

Job satisfaction was measured using a single item measure (Thatcher & Milner, 2012). Job satisfaction was assessed by asking "Taking everything into consideration how do you feel about your job as a whole?" Answers ranged from (1) very dissatisfied to (5) very satisfied. Authors such as Scarpello and Campbell (1983) and Wanous et al (1997) found that single item measures of job satisfaction were not unreliable and were at least as good as numerous items when assessing global measures of job satisfaction. Warr (2012) also stated that single item measures focusing entirely on satisfaction itself have the advantage of directly operationalising the essence of the concept.

Productivity

Perceived productivity was measured by asking participants to rate their productivity at four different time periods. The questions asked participants "On a scale 0-100 percent (where 100% is full capacity), rate "how well you have been working over the last month in relation to your full capacity". In addition to this they were asked to rate their productivity over the last 2-3 months, 4-6 months and 7-12 months. They were also asked what the single most important factor was that impacted (increased/decreased) their productivity during each time period.

Absenteeism

Absenteeism records were obtained from the company after the respondents were matched at Time 1 and Time 2 for each of the groups. The absenteeism data contained the number of sick leave days that each employee had taken on a month by month basis. The number of sick leave days taken one year prior to moving into their respective green buildings and one year after the move were used in assessing absenteeism differences. The same time periods were used for those who did not move to determine if there were any differences in employee absenteeism patterns. The reasons for absenteeism were not investigated in this study, only the number of sick leave days taken by the employees were considered.

Due to the fact that the data was collected as part of a larger study, measures of other variables were included in the self-report questionnaires, however for the aim of this study,

only the measures on these particular variables were utilised by the researcher. The information utilised specifically for this study has been highlighted on the questionnaire (See Appendix 1).

Procedure

Participants were invited to take part in the study via e-mail. The company had generated a random sample of employees for the researchers which contained employee numbers and their e-mail addresses for the researchers to be able to contact them. The researchers sent out a total of 3305 invitation emails to this random sample with a link connecting the employee to the questionnaire. The questionnaires were distributed in this manner before the employees moved into their respective green buildings and 12 months post occupancy in each of the green buildings. Participants were given two weeks to respond to the questionnaire. Reminders were sent out 1 week after the initial invitation to participate was sent and again the day before the close of the two week period. The survey contained a cover letter (participant information sheet) which introduced the researchers and their affiliations, and invited the employees to participate, and also informed them of the aim of the study. Once participants completed the questionnaire, they were requested to click the 'submit' button to send through their responses to the researchers. Clicking the submit icon was taken as consent to participate in the study. As data were collected at different points in time employees had the option to provide their employee number in order for the researchers to match the participant responses at each time that the survey was administered. The employee numbers were also used to match the participants' survey responses to their absenteeism data records provided by the organisation. The only information known to the researchers was the employee number and anonymity was assured as the researchers were not aware of the employee names. Similarly the organisation only had access to names and other employee information but not to their responses on the survey.

Analysis

Inferential statistics were used to analyse the data and answer the research questions. Cronbach alpha was used to examine the reliability of the WEMWBS, the SBS questions and the questions assessing the perceptions of the physical environment. The data collected on each of the measures was initially analysed to determine if the assumptions for parametric tests were met. A matched-pairs *t*-test was conducted on the data that met the requirements for a parametric test. For the data that failed to meet the assumptions for the parametric test,

the equivalent non-parametric test, the Wilcoxon Signed Ranks Test was used. (Huck, 2004). These analyses were used for all of the groups, that is, the employees occupying the green buildings in Johannesburg and Durban as well as those who remained in the conventional buildings. These tests were conducted in order to determine if the employees exhibited any difference on measures of physical and psychological wellbeing, job satisfaction, productivity and absenteeism before moving into their respective green buildings and 12 months post occupancy in each of the green buildings. The same analyses were performed for those participants who did not move into the green buildings, over the same time period.

Correlations and forward stepwise multiple regression analyses were also carried out to ascertain the extent to which the IEQ design features of the buildings such as ventilation, thermal conditions and lighting, were associated with employee wellbeing and productivity, which were the dependent variables. These analyses were conducted on the two groups that moved into the Johannesburg and Durban green buildings, taking into account their perceptions of the physical environment (independent variables) at Time 2 and determining which of these aspects, if any, significantly impacted employee wellbeing and productivity measures, also taken at Time 2. Each of the independent variables were entered into the regression equation in a stepwise manner if it accounted for a significant proportion of variance in each of the dependent variables (Huck, 2004).

The computer package SPSS for Windows (version 20) was used for the calculations. A significance level of .05 was used in determining significance of the results within this study.

Ethical Considerations

This research was conducted using existing data that had already been collected as part of a larger study and as a result will not involve any direct contact with the participants. Participants were informed of the purpose of the research and participation was on a voluntary basis as they were under no obligation to take part in the study. Furthermore there were no advantages or disadvantages to individuals who participated versus those who decided not to participate. The participant information sheet informed participants that consent to participate would be taken once they submitted their responses by clicking on the 'submit' button on the survey. They were free to withdraw at any point before submitting their responses. Employee numbers were requested in order to match employee responses at

the different data collection times and to match to the absenteeism data. However the researchers did not have access to employee names, therefore the respondents were anonymous to the researchers. The respondents were also anonymous to the organisation as they did not have access to the employee responses. Only the researchers had access to the data which is kept in a secure database, assuring confidentiality of the responses. Feedback of the results was given to the organisation based on aggregate and not individual responses. A summary of the results was available to the employees via their in-house journal, Sustainability Outlook.

Chapter 3: Results

Research Question One

The first research question investigated in this study aimed to determine whether or not there was a difference in employee wellbeing (physical and psychological), job satisfaction, absenteeism and perceived productivity of employees before moving into each of the green buildings, and 12 months post occupancy in each of the buildings.

In order to test this, matched-paired *t*-tests were conducted on the data that met the assumptions for this parametric test, and the Wilcoxon Signed Ranks Test was conducted on the data that failed to meet these requirements. None of the data collected on the dependent variables for Phase II met the assumptions for parametric tests, therefore Wilcoxon Signed Ranks Tests were conducted for the group that moved to the green building and the group that stayed in the conventional building. Certain data collected for the Ridgeside building did meet the assumptions for the parametric matched-paired *t*-tests to be conducted. The matched-paired *t*-test was run on psychological wellbeing data for the groups that moved and did not move, as well as on the physical wellbeing data collected for the group that moved to the green building. Wilcoxon Signed Ranks Tests were performed on the rest of the Ridgeside data.

The results shown in Table 3 revealed no significant differences in psychological wellbeing, physical wellbeing, job satisfaction, perceived productivity and absenteeism for the Phase II occupants before moving into the green building and 12 months after occupying the green building. The median scores for psychological wellbeing increased from Time 1 to Time 2 indicating higher psychological wellbeing at Time 2, however this increase was not statistically significant. Physical wellbeing and perceived productivity scores decreased slightly from Time 1 to Time 2 but again this was not statistically significant. The median scores for job satisfaction and absenteeism were the same at Time 1 and Time 2. Median scores are discussed as these are the averages computed by the Wilcoxon Signed Ranks Tests.

The results shown in Table 4 for Phase II of those who remained in the conventional building indicated significant differences in the productivity and absenteeism measures. Perceived

productivity increased from Time 1 to Time 2, as well as did absenteeism rates from Time 1 to Time 2. No significant differences were found in psychological wellbeing, physical wellbeing and job satisfaction measures. Median scores showed a decrease in psychological wellbeing and an increase in physical wellbeing and job satisfaction from Time 1 to Time 2 in the Phase II conventional building.

Table 3: Comparison of Organisational Outcomes from T1 to T2 – Phase II Green building

Phase II: Moved to Green Building (N=84)				
Dependent variable	Time 1 Median	Time 2 Median	*Z*-value	Sig. p-value
Psychological Wellbeing	3.50	3.93	-.544	.587
Physical Wellbeing	3.10	3.01	-.068	.946
Job Satisfaction	4.00	4.00	-1.552	.121
Perceived Productivity	85.00	82.33	-.537	.591
Absenteeism	2.00	2.00	-.317	.752

Table 4: Comparison of Organisational Outcomes from T1 to T2 – Phase II Conventional Building

Phase II: Conventional Building (N=50)				
Dependent variable	Time 1 Median	Time 2 Median	*Z*-value	Sig. p-value
Psychological Wellbeing	3.64	3.57	-1.205	.228
Physical Wellbeing	3.13	3.17	-.776	.438
Job Satisfaction	3.5	4.00	-.513	.608
Perceived Productivity	80.83	88.00	-2.060	**.039**
Absenteeism	1.50	4.00	-2.491	**.013**

The results of Ridgeside for the group that moved to the green building, as shown in Table 5, indicated significant differences in physical wellbeing and perceived productivity measures.

Both physical wellbeing and productivity measures of this group increased from Time 1 to Time 2. No significant differences were found on their measures of psychological wellbeing, job satisfaction and absenteeism. The median scores on psychological wellbeing showed a small decrease form Time 1 to Time 2 which was not statistically significant. The median scores for job satisfaction were the same at Time 1 and Time 2, while the median absenteeism scores decreased from Time 1 to Time 2, however this decrease failed to be statistically significant.

No significant differences were found in psychological wellbeing, physical wellbeing, job satisfaction, perceived productivity and absenteeism for the Ridgeside group that remained in the conventional building, shown in Table 6. Median scores indicated a decrease in psychological wellbeing and productivity, an increase in physical wellbeing and absenteeism whilst job satisfaction remained the same from Time 1 to Time 2.

Table 5: Comparison of Organisational Outcomes from T1 to T2 – Ridgeside Green Building

Ridgeside: Moved to Green Building (N=27)								
Dependent variable	Time 1 Mean	Time2 Mean	*t*-value	Sig. p-value	Time 1 Median	Time 2 Median	*Z*-value	Sig. p-value
Psychological Wellbeing	3.59	3.57	-.179	.860				
Physical Wellbeing	3.01	3.32	4.026	**.000**				
Job Satisfaction					4.00	4.00	-.363	.717
Perceived Productivity					86.67	92.67	-2.153	**.031**
Absenteeism					3.00	2.00	-.606	.544

Table 6: Comparison of Organisational Outcomes from T1 to T2 – Ridgeside Conventional Building

Ridgeside: Conventional Building (N=14)								
Dependent variable	Time 1 Mean	Time2 Mean	*t*-value	Sig. p-value	Time 1 Median	Time 2 Median	*Z*-value	Sig. p-value
Psychological Wellbeing	3.83	3.77	-.504	.622				
Physical Wellbeing					3.33	3.46	-1.225	.220
Job Satisfaction					4.00	4.00	-.378	.705
Perceived Productivity					91.50	83.17	-.664	.507
Absenteeism					3.50	4.00	-2.76	.783

Research Question Two

The second research question in this study aimed to determine which of the IEQ design features of the green buildings influenced wellbeing and perceived productivity. In order to determine this, correlations and forward multiple regression analyses were conducted using the perceptions of the physical environment measure of the Phase II and Ridgeside groups at Time 2 who were occupying the green buildings.

The results of the regression analyses for Phase II, shown in Table 7, for the model fitting the psychological wellbeing predictor was statistically significant, $F(1, 74)=6.36$, $p=.014$. The model accounted for 7.9% of the variance in psychological wellbeing. The model fitting the physical wellbeing predictors were also statistically significant, $F(5, 70)=14.58$, $p<.000$, and accounted for 51% of the variance in physical wellbeing. The job satisfaction model was statistically significant, $F(2, 73)=6.64$, $p=.002$, with the predictor variables explaining 15.4% of the variance in job satisfaction. The perceived productivity and absenteeism models were statistically significant each with one predictor in the models. The perceived productivity model, $F(1, 74)=5.25$, $p=.250$, accounted for 6.6% of the variance in productivity. The absenteeism model, $F(3, 72)=5.81$, $p=.001$, explained 19.5% of the variance in absenteeism.

The condition index for each of the models and intercept were less than 30, thus the collinearity between the variables was not a problem.

Table 7: Multiple Regression Analyses – Phase II

	R-Squared	*t*	Sig.
Psychological Wellbeing	.079		
Air too humid		2.522	.014
Physical Wellbeing	.510		
Air too dry		3.574	.001
Lighting too dim		3.222	.002
Unpleasant odour in the air		2.339	.022
Electrostatic Shocks		2.411	.019
Distracting ambient noises		1.999	.050
Job Satisfaction	.154		
Lighting too bright/glaring		3.031	.003
Too little air movement		2.194	.031
Perceived Productivity	.066		
Air too dry		2.291	.025
Absenteeism	.195		
Air too dry		-2.942	.004
Dusty air		-2.434	.017
Electrostatic Shocks		2.002	.049

The results of the regression analyses for Ridgeside (Table 8) showed no significant predictors for psychological wellbeing, job satisfaction and perceived productivity. The correlations between these dependent variables and the predictor variables were examined

and none of the correlations were statistically significant. The model for physical wellbeing was found to be statistically significant, $F(2, 23)=8.39$, $p=.002$. The model accounted for 42.2% of the variability of physical wellbeing. The absenteeism model was also statistically significant, $F(4, 21)=6.83$, $p<.001$, and explained 56.5% of the variability of absenteeism. The condition index for each of the models and intercept were less than 30, thus the collinearity between the variables was not a problem.

Table 8: Multiple Regression Analyses - Ridgeside

	R-Squared	*t*	Sig.
Physical Wellbeing	.422		
Lighting too dim		2.733	.012
Too drafty		2.281	.032
Absenteeism	.565		
Temperature too cold		-4.130	.000
Lighting too bright/glaring		3.444	.002
Too drafty		2.217	.038
Air too humid		-3.613	.002

The multiple regression results for Phase II indicated that the largest proportion of variance is explained by the variables that predict physical wellbeing which is dry air, lighting that is too dim, unpleasant odour, electrostatic shocks and distracting ambient noises. The significant predictors of absenteeism are air too dry, dusty air and electrostatic shocks. The amount of variance explained is moderate. Lighting that is too bright and too little air movement affect job satisfaction and a moderate amount of variance is explained by these predictors. The variance explained by the predictors of psychological wellbeing and perceived productivity are relatively low, indicating that only air that is too humid significantly predicts psychological wellbeing, and that only air that is too dry predicts perceived productivity.

The multiple regression results for Ridgeside indicated that none of the perceptions of the physical environment variables significantly predicted psychological wellbeing, job satisfaction and perceived productivity. Two variables were found to significantly predict physical wellbeing, lighting that is too dim and areas that are too drafty. These predictors

explained a large proportion of the variance in physical wellbeing. There were four significant predictors of absenteeism, temperature that is too cold, lighting that is too bright/glaring, air that is too humid and areas that are too drafty. A large proportion of the variance was also accounted for by these predictors.

Research Question Three

The third research question in this study aimed to determine if the IEQ design features differ within the Phase II and Ridgeside green buildings and if they have differing influences on the organisational outcomes. The results demonstrate that the physical environment perceptions are different within each of the green buildings as the resulting impact on the dependent variables in each of the buildings were not the same. Furthermore, nothing significantly impacted on psychological wellbeing, job satisfaction and perceived productivity measures in the Ridgeside building.

In the Phase II building, each of the dependent variables were affected by one or more of the physical environment conditions, whereas in the Ridgeside building only physical wellbeing and perceived productivity were predicted by the physical environment conditions.
The predictors of physical wellbeing for both buildings were different, with the only common predictor being lighting that is too dim. There were no common predictors on absenteeism measures which were different for each building.

Overall within Phase II, lighting, either too bright/glaring or too dim, air being too humid, dusty, dry or too little air movement, noise, unpleasant odour and electrostatic shocks significantly impacted the organisational outcome measures. The main variables impacting on the organisational outcomes in Phase II were air and lighting conditions. Within the Ridgeside building, lighting, either too bright/glaring or too dim, drafty conditions, temperature too cold and air too humid had a significant impact only on the physical wellbeing and absenteeism measures. Drafty conditions affected both of the measures in the Ridgeside building. The main variables affecting physical wellbeing and absenteeism measures in the Ridgeside building were lighting, air and temperature and drafty conditions.

Chapter 4: Discussion

The study investigated whether or not improved IEQ conditions in green buildings resulted in improved psychological and physical wellbeing, perceived productivity, job satisfaction and absenteeism measures of the occupants. The study also examined which of the IEQ design features of each of the green buildings influenced wellbeing and perceived productivity, and whether or not the IEQ design features differ between the Phase II and Ridgeside buildings and subsequently have differing influences on the organisational outcomes measured.

Research Question One

The occupants in the Phase II green building did not show any significant differences in psychological wellbeing, physical wellbeing, job satisfaction, perceived productivity and absenteeism measures before the move, and 12 months post occupancy in the green building. The occupants in the conventional building did not demonstrate any significant differences during the same time periods on measures of psychological wellbeing, physical wellbeing and job satisfaction. There was however a significant difference in their perceived productivity measures which increased from Time 1 to Time 2, as well as their absenteeism measures which also increased from Time 1 to Time 2.

The perceived productivity measures of the occupants in the Phase II conventional building increased over the time period even though they were not in the green building. A possible explanation for the increase in perceived productivity in the conventional building could be due to the fact that this group did not have to incur the inconvenience of moving to a new building, which could disrupt productivity levels. The move is a change process which can induce feelings of tension and insecurity which causes distress to employees which can ultimately have a negative impact on their physical and mental wellbeing (Swanson & Power, 2001). Heerwagen (2000) argued that organisations take weeks to months to recoup lost efficiency as a result of moving. Perhaps over a time period of more than 12 months productivity benefits may be recognised within the green building.

The absenteeism measures for the occupants within the conventional building increased significantly from Time 1 to Time 2. Although there was no significant decrease in absenteeism within the green building, the median absenteeism measures were the same at Time 1 and Time 2. Studies by the Victoria and Kador Group (2006) found a 39% decrease in absenteeism rates of employees that were monitored before moving into a green building and

nine months after the move. A further study by Bergs (2002) found a decrease of 2.5% in employee absenteeism rates, attributed to better IEQ conditions. A decrease in absenteeism rates was not seen in the Phase II green buildings 12 months after the move but had remained the same, whereas the absenteeism rates did increase in the conventional building. This may suggest that the positive benefits of the green building environment may be beginning to surface and given more time, longer-term benefits may be seen in a reduction in employee absenteeism.

Generally the findings for the Phase II building were not consistent with the findings in the literature which have shown significant increases in psychological wellbeing, physical wellbeing, job satisfaction and productivity (Fisk, 1999; Fowler & Rauch, 2008; Hedge, 2000; Heerwagen, 2000; Kats, 2003; Miller et al., 2009; Paul & Taylor, 2008; Von Paumgartten, 2003 & Wyon, 2003). The impact of the move may have negatively affected these outcomes and the organisation may still be in the process of regaining efficiency lost due to the move (Heerwagen, 2000). The absenteeism results are promising in that although there was no decrease in absenteeism of the occupants in the green building, there was no increase in absenteeism either, whereas there was a significant increase in absenteeism in the conventional building. The 12 month post occupancy time period may be an insufficient time period to see improvements in the organisational outcome measures within the Phase II green building.

The results within the Ridgeside green building seem to be more consistent with the literature (Fisk, 1999; Fowler & Rauch, 2008; Hedge, 2000; Heerwagen, 2000; Kats, 2003; Miller et al., 2009; Paul & Taylor, 2008 & Wyon, 2003) in that significant increases were found in measures of physical wellbeing and productivity of the occupants. However, as in the Phase II green building, no significant increases were found in measures of psychological wellbeing, job satisfaction and absenteeism. Furthermore, no significant differences were seen in any of the measures of the occupants in the conventional building.

The occupants in the Ridgeside green building also experienced the disruption of moving to a new building however their perceived productivity measures still increased over the 12 months post occupancy period, unlike the occupants of the Phase II green building. Perhaps for these occupants the move did not result in lost efficiency or perhaps the 12 month time period was sufficient to gain any loss in efficiency, resulting in them being able to see the improvements within the green building environment 12 months after moving. Occupants

may also not necessarily be negatively affected by the move and in some cases a move to new premises leads to a boost in productivity as workers are invigorated by the change in their work environment. These effects, should they be present, diminish rather quickly (Sustainability Victoria & Kador Group, 2006) and therefore an increase in productivity in this case is likely to be attributed to the benefits associated with the green building environment. Although the perceived productivity measures of the occupants in the conventional building showed no significant difference, the median productivity measures indicated a decrease in productivity from Time 1 to Time 2.

Physical wellbeing measures also significantly increased in the Ridgeside green building, consistent with the literature that physical wellbeing is significantly better in green buildings versus conventional buildings (Burge, 2012; Fisk, 1999; Heerwagen, 2000; Klitzman & Stellman, 1989; Knowles et al., 2002 & Niemla et al., 2006). As indicated in the literature, increased physical wellbeing leads to a reduction in absenteeism. The median absenteeism measures showed a decrease in absenteeism, even though the difference was not statistically significant, perhaps in the long-term significant differences will be seen. The median absenteeism measures for the occupants in the conventional building increased from Time 1 to Time 2, and again may lead to a significant increase in absenteeism over time.

The literature findings indicated that ventilation, daylight and thermal comfort influence productivity levels (Hedge, 2000; Fisk, 1999; Kats, 2003; Lan et al., 2011; Leaman et al., 2007; Paul & Taylor, 2008; Parsons, 2000; Wyon, 2000). A further explanation of the perceived productivity levels being higher in the Ridgeside green building could be due to these factors. Ridgeside scored higher than Phase II on ventilation rates and daylight on their respective scorecards. Both buildings however received zero points for thermal comfort but overall Ridgeside scored higher on the factors thought to affect productivity.

The levels of job satisfaction indicated by the median scores for both the Phase II and Ridgeside buildings remained the same at Time 1 and Time 2. The median scores on job satisfaction were relatively high at Time 1 with a score of four out of five, and remained the same at Time 2. A research study by Steemers and Manchanda (2010) found that IEQ features such as air quality, lighting and temperature were related to occupants' job satisfaction. This link was not found in this study.

Research Question Two

The multiple regression analyses showed that within each of the green buildings, different IEQ factors influence wellbeing and perceived productivity which are indicated in tables 9 and 10 below.

Table 9: Phase II: Summary of IEQ Factors Significantly Impacting on Organisational Outcomes

	Psychological Wellbeing	**Physical Wellbeing**	**Job Satisfaction**	**Perceived Productivity**	**Absenteeism**
Air too humid	X				
Air too dry		X		X	X
Too little air movement			X		
Dusty air					X
Electrostatic shocks		X			X
Unpleasant odour in the air		X			
Lighting too bright/glaring			X		
Lighting too dim		X			
Distracting ambient noises		X			

Table 10: Ridgeside: Summary of IEQ Factors Significantly Impacting on Organisational Outcomes

	Physical Wellbeing	**Absenteeism**
Lighting too dim	X	
Lighting too bright/glaring		X
Too drafty	X	X
Air too humid		X
Temperature too cold		X

In the Phase II green building, different IEQ components predicted each of the organisational outcomes. The IEQ components that are important to consider in the design are indoor air quality, lighting and noise. Components of air quality came up most often as predictors with air being too humid, too little air movement, dusty air and the air being too dry impacting on the organisational outcomes. Dry air is a common predictor for physical wellbeing, perceived productivity and absenteeism. Electrostatic shocks experienced will be related to the non-optimal air conditions. Lighting issues regarding lighting being either too dim or too bright/glaring were also significant predictors of job satisfaction and physical wellbeing. Distracting ambient noises was also a significant predictor of physical wellbeing. Physical wellbeing is seen to be affected by the most IEQ components, followed by absenteeism and job satisfaction and lastly psychological wellbeing and perceived productivity with one predictor each.

The study findings of air quality and lighting predominantly impacting physical wellbeing and absenteeism are consistent with the literature findings. Previous research indicated that improved indoor air quality can lead to improved physical wellbeing of occupants, as improved air quality reduces symptoms associated with SBS, which in turn reduces absenteeism (Burge, 2012; Fisk, 1999; Heerwagen, 2000; Kats, 2003; Niemla et al., 2006; Ries et al., 2006). Lighting conditions have also been found to be important for vision when performing tasks and for its non-visual biological effects which influence concentration, mood and alertness. Light intensity and glare can also cause strain on the eyes and headaches, which impacts physical wellbeing (Begemann et al., 1997; Fisk, 2000; Hedge, 2008; Lee & Kim; Leslie, 2003; Parsons, 2000). Indoor air quality and lighting conditions should be monitored carefully within the Phase II building in order to determine the impact that these

conditions have on the organisational outcomes, particularly physical wellbeing and absenteeism.

In the Ridgeside green building, different IEQ components were found as significant predictors only for physical wellbeing and absenteeism. No significant predictors were found for psychological wellbeing, job satisfaction and perceived productivity. The important IEQ factors to consider in the design of the Ridgeside green building are concerning lighting, air and temperature. Lighting that is too dim and drafty conditions significantly predicted physical wellbeing. There were more significant predictors for absenteeism which also included drafty conditions, lighting that is too bright/glaring, air that is too humid and the temperature being too cold. There was a significant increase in perceived productivity within the Ridgeside green building, however these predictors should be taken into consideration to prevent possible deterioration in productivity levels due to these IEQ components. Absenteeism median scores did indicate a decrease however, on improving the conditions that affect absenteeism, there will be a better chance of seeing significant improvements in these measures.

Research Question Three

It can be seen that although both the Phase II and Ridgeside offices are green buildings, different IEQ components were found to affect the organisational outcomes differently. The only common significant predictor found for both buildings was lighting that is too dim affecting physical wellbeing in both green buildings. The remaining predictors were different in each of the buildings. Temperature as a predictor was only found in the Ridgeside building.

Overall on the IEQ component of the scorecard, Ridgeside only came out one point ahead of Phase II. Both Phase II and Ridgeside score the full two points on air change effectiveness but Ridgeside did score one point higher on ventilation control which may have a difference on the perceptions of the indoor environment, as air quality components were significant predictors on all of the organisational outcomes within the Phase II building. Only air humidity was a concern within the Ridgeside building. Ridgeside scored one point for daylight and daylight glare control, where Phase II received zero points for these components on the scorecard. Phase II did however score a point for electric lighting levels where Ridgeside received zero points. In this instance, lighting being too dim or too bright/glaring

affected outcomes in both buildings and the levels of lighting, whether natural or electric should be monitored to produce comfortable conditions for the occupants. Both buildings scored zero points for thermal comfort however thermal conditions only seem to be a concern in the Ridgeside building where temperatures that are too cold impact absenteeism. The fact that Phase II scored zero on this component may not be too much of an issue given that the occupants' perceptions of the physical environment do not seem to find thermal conditions uncomfortable in the building. All these factors should be taken into consideration on maintaining the IEQ environment within each of the buildings.

It can clearly be seen that the IEQ design features differ within the two green buildings and subsequently have differing effects on the organisational outcomes. It is difficult to provide an IEQ environment that all occupants will be satisfied with as it is difficult to perfectly balance the IEQ conditions at a level that is optimal for everyone. Certain ranges of temperature or ventilation rates for example may be acceptable to many employees but not to all. A study reported by the Victoria and Kador Group (2006) found that if very good IEQ conditions were in place in a building, a maximum of 95% of all occupants might be satisfied. General guidelines office specifications stipulated by the Victoria and Kador Group (2006) for heating and air conditioning recommend indoor temperature control at between 21 and 24 degrees Celsius however these temperatures may not necessarily be comfortable for everyone (Sustainability Victoria & Kador Group, 2006). Optimum temperatures required to perform tasks depend on the nature of the task and varies among individuals and over time. In an attempt to alleviate some of these issues, it is argued that occupants be given control to be able to adjust temperature and lighting settings for example (Fisk, 1999). The option of individual control is not given to either of the occupants in the Phase II and Ridgeside buildings. This may be a further factor to consider in future monitoring of the occupants perceptions of the physical environment.

Differing results were found between the Phase II and Ridgeside buildings on the organisational outcomes measured, and the perceptions of the physical environment, even though they are both classified as green buildings and both have achieved a four-star accredited rating. Therefore, buildings can be classified as green buildings but the aspects that actually make it "green" can differ widely and as a result have differing effects on the occupants. The findings of the studies reported in the literature review also differ quite substantially. For example certain studies reported different decrease rates in absenteeism

(ranging from 39% to 2.5%) than others due to improved IEQ conditions (Bergs, 2002; Sustainability Victoria & Kador Group, 2006).

The two buildings received different scores on the IEQ component of the scorecard, with Ridgeside obtaining a total of 16 points and Phase II a total of 14 points. Significant findings were found only in the Ridgeside green building which even though they only scored two points higher than Phase II on the IEQ component, may be an indication that the overall IEQ conditions may be better within this building. Of the specific IEQ components considered in this study, Ridgeside scored better than Phase II on ventilation rates, daylight and daylight glare control. Phase II however scored better on electric lighting levels and external views. There are apparent differences in the IEQ design features of both the buildings and therefore the IEQ conditions in each of the buildings should be continuously monitored and improved, which may lead to benefits in occupants experiencing improved wellbeing, productivity, job satisfaction and a reduction in absenteeism.

In summary the results are encouraging for the green building occupants as well as the organisation to reap the benefits associated with better IEQ design features. The occupants in the green buildings may not have been better off in terms of all the organisational outcomes but they were not worse off either. Perhaps a longer-term view needs to be adopted in order to see significant improvements, and continuous monitoring and evaluation of the employee perceptions of the physical environment should be maintained in order to ensure comfortable working environments for employees.

Theoretical and Practical Implications

Literature findings generally document a positive relationship between IEQ and occupant wellbeing and productivity within green buildings, with improved IEQ conditions leading to improved occupant wellbeing and productivity (Fisk, 1999; Fowler & Rauch, 2008; Hedge, 2000; Heerwagen, 2000; Kats, 2003; Paul & Taylor, 2008 & Wyon, 2003). Literature findings also document that improved IEQ conditions result in a decrease in absenteeism and increase in job satisfaction in the occupants of green buildings (Bergs, 2002; Heerwagen, 2000; Fisk, 1999; Ries et al., 2006; Von Paumgartten, 2003).

Practical demonstrations within this study showed that lighting conditions and air quality have the most significant influence on the organisational outcomes investigated. Furthermore, this study found significant improvements in productivity and physical wellbeing levels of occupants in the Ridgeside green building, but no significant differences were found on psychological wellbeing, job satisfaction and absenteeism in either of the green buildings, which is contrary to the general findings documented in the literature.

Therefore the findings of this study demonstrated that IEQ components do have an impact on organisational outcomes, however the degree and manner in which the outcomes are influenced differ depending on the IEQ design features of the building. The IEQ design features within the Phase II and Ridgeside buildings were not the same and as a result, the impact on the organisational outcomes also differed within the two buildings.

Limitations of the Study

There are a number of limitations that may have affected the final results of the study. The study looked at the influence of IEQ conditions on organisational outcomes such as psychological and physical wellbeing, productivity, absenteeism and job satisfaction. These organisational outcomes may have been affected by other factors, and not only factors directly related to the IEQ environment within the buildings. Spector (1994) argued that there is increasing evidence that reports of job conditions are affected by many aspects, including the attitudes, cognitive processes, moods and personality of the respondents. Aspects such as physical wellbeing may also be affected by chronic illnesses that participants may have and not by the quality of the indoor environment. Occupants also only spend a limited amount of time within the buildings' IEQ environment, and therefore there are other unknown factors that may impact their wellbeing whilst they are not in the building which can impact the organisational outcomes measured.

The study relies on self-report measures of psychological and physical wellbeing, productivity and job satisfaction, which as mentioned may be influenced by factors other than IEQ conditions, and the sample sizes are not very large in each of the buildings when considering the number of people that the questionnaires were distributed to. The design of this study however was longitudinal which compared the same person to themselves at Time 1 and Time 2, and comparison groups that did not move to the green buildings were used to

compare the findings during the different time periods. The absenteeism data used in the study did not rely on self-report measures, however the reasons that the occupants may have taken sick leave may, once again not have been due to illnesses related to IEQ. Furthermore due to the fact that participation was voluntary, self-report measures were only obtained from those employees who chose to participate in the study by completing the questionnaire, limiting the number of responses that could potentially have been collected.

The study looked at the IEQ design features within two buildings and therefore constitutes a case study on these two particular buildings. The design features that make a building "green" differ across buildings and as a result the generalisability of these findings may be limited in that it cannot be assumed that the same outcomes will be found within other green buildings.

Directions for Future Research

Certain findings of the study were inconsistent with the literature findings which generally conclude that improved IEQ environments led to improved occupant wellbeing and productivity. The findings of the study may not have shown improvements on all of the organisational outcomes investigated however the occupants were not shown to be any worse off either. This may be an indication that improvements may occur over a longer period of time and therefore follow-up investigations are recommended to determine if the advantages of the change in IEQ environments may be seen beyond the 12 month period.

Due to the fact that the data collected relies on self-report measures, except for absenteeism, perhaps a more objective measure of productivity may be used. As mentioned previously, this may be difficult to quantify but may be a possible alternative, depending on the practicality of being able to ascertain a reliable and accurate measure of employee productivity.

In order to obtain a better understanding of the impact that IEQ conditions have on organisational outcomes, more green buildings should be investigated to gather more responses and case studies. Exploring different types of green buildings and how they differ in terms of their IEQ conditions will help develop a better view of the design features that contribute towards improved wellbeing, productivity and job satisfaction, as well as decreases in absenteeism.

Lastly, given that significant results were demonstrated in the Ridgeside green building with regards to physical wellbeing and productivity, and no significant improvements were seen in the Phase II green building, the IEQ design features within the Ridgeside building should be examined in more detail. This may reveal which features may be better implemented or designed in the Ridgeside building and the necessary changes can be made within the Phase II building in order to recognise the benefits associated with improved IEQ.

Conclusion

The findings of the study demonstrated that there were significant differences in the occupants' physical wellbeing and productivity measures, which had increased from before moving into the Ridgeside green building, and 12 months post occupancy in the green building. No significant differences were found on the measures of psychological wellbeing, job satisfaction and absenteeism for the occupants' of the Ridgeside green building.

The findings for the Phase II green building did not reveal any significant differences on psychological and physical wellbeing, productivity, job satisfaction and absenteeism measures taken before the move to the green building, and 12 months post occupancy in the green building for the occupants.

The main IEQ components that were found to influence wellbeing and productivity within the Phase II and Ridgeside buildings were air quality and lighting conditions. It is therefore important to consider the design elements that affect these IEQ conditions in order to create and maintain comfortable working environments within the green buildings.

Both the Phase II and Ridgeside buildings are classified as green buildings and they have both achieved a four-star accredited rating. However, significant differences in the organisational outcomes measured were only found in the Ridgeside green building, and only on two (physical wellbeing and productivity) out of the five organisational outcomes investigated in the study. The categories that green buildings are evaluated on include components such as Management, Energy, Transport, Water and Materials, Land Use and Ecology, Emissions and Innovation. IEQ is only one of the components which directly affect

the occupants of the buildings. As a consequence, a building can be rated as being "green" without paying much attention to the IEQ design features and the subsequent impact on the occupants. Therefore it is important to consider not only what makes a building green and benefits the environment, but also to consider which of these features will lead to benefits for the occupants of green buildings.

Abair (2008) argues that the momentum behind the green building movement continues to grow amid issues of global warning concerns and the rising cost of fossil fuels. Worldwide, construction and maintenance consumes 40% of the world's energy, 65% of all electricity and 40% of raw materials. In light of these figures, there is a drive to implement environmentally friendly building efforts in the hope of establishing sustainable design and construction procedures (Abair, 2008). Perhaps the focus of what constitutes a green building is aligned more with resource efficiency and to a lesser extent the benefits to its occupants. For organisations to be truly effective and succeed across the levels of environmental sustainability, organisational effectiveness and human wellbeing, greater emphasis needs to be placed on the green building design features that will ultimately lead to benefiting its occupants.

Reference List

Abair, J. W. (2008). Green buildings: What it means to be "green" and the evaluation of green building laws, *Urban Lawyer*, *40*, 623-632.

Begemann, S.H.A., van den Beld, G.J., & Tenner, A.D. (1997). Daylight, artificial light and people in an office environment, overview of visual and biological responses, *International Journal of Industrial Ergonomics, 20,* 231-239.

Bergs, J. (2002). *The effect of Healthy Workplaces on the Well- being and Productivity of Office Workers*. http://www.plants-in-buildings.com/documents/Symposium-Bergs.pdf [accessed June 2012].

Bluyssen, P.M. (2010). Towards new methods and ways to create healthy and comfortable buildings, *Building and Environment, 45*, 808-818.

Burge, B.S. (2004). Sick building syndrome, *Occup Environ Med, 61,* 185-190.

Currall, S.C., Towler, A.J., Judge, T.A. & Kohn, L. (2005). Pay satisfaction and organizational outcomes, *Personnel Psychology, 58*, 613-640.

Danna, K. & Griffin, R.W. (1999). Health and wellbeing in the workplace: A review and synthesis of the literature, *Journal of Management, 25,* 357-384.

Fisk, W. J. (1999). Estimates of potential nationwide productivity and health benefits form better indoor environments: an update. In J. D. Spengler, J.M. Samet, & J.F McCarthy (Eds.), *Indoor Air Quality Handbook* (pp. 1-38), McGraw Hill.

Fisk, W.J. (2000). Health and productivity gains form better indoor environments and their relationship with building energy efficiency, *Annual Review Energy Environment, 25,* 537-566.

Fowler. K.M. & Rauch, G.M. (2008). Assessing green building performance: a post-occupation evaluation of 12 GSA buildings, in U.S. General Services Administration Report available from: www.gsa.gov/graphics/pbs/GSA_Assessing_Green_Full_Report.pdf [accessed August 2011].

Harter, J.K., Schmidt, F.L. & Keyes, C.L. (2002). Well-being in the workplace and its relationship to business outcomes: A review of the Gallup Studies, available from: www.media.gallup.com/Documents/whitePaper--Well-BeingInTheWorkplace.pdf [accessed November 2012].

Hedge, A. (2000). Where are we in understanding the effects of where we are? *Ergonomics*, *43*, 1019-1029.

Hedge, A. (2008). The sprouting of "green" ergonomics, *Human Factors and Ergonomics Society Bulletin*, *51*, 1-8.

Hedge, A., Erickson W.A. & Rubin, G. (1996). Predicting sick building syndrome at the individual and aggregate levels, *Environment International*, *22*, 3-19.

Heerwagen, J. (2000). Green buildings, organizational success and occupant productivity, *Building Research & Information*, *28*, 353–367.

Heerwagen, J. (2000). Do green buildings enhance the wellbeing of workers, *Environmental Design and Construction*, *2*, 24-30.

Heerwagen, J. & Hase, B. (2001). Building biophilia: connecting people to nature in building design, *Environmental Design and Construction*, *3*, 30-36.

Heschong, L., Wright, R.L. & Okura, S. (2002). Daylighting impacts on human performance in school, *Journal of the Illuminating Engineering Society*, *Summer 2002*, 101-114.

Hewitt, D., Higgins, C., Heatherly, P. & Turner, C. (2005). A market-friendly post-occupancy evaluation: Building performance report, a report for the Northwest Energy Efficiency Alliance, available from: www.utahcleanenergy.org/Files/u1/FinalReport-BPR_ContractC10091_.pdf [accessed September 2011].

Hillier, D., Fewell, F., Cann, W. & Shepard, V. (2005). Wellness at work: Enhancing the quality of our working lives, *International Review of Psychiatry*, *17*, 419-431.

Huck, S. W. (2004). *Reading statistics and research (fourth edition).* Boston: Pearson Education Inc.

Kats, G. (2003). The costs and financial benefits of green buildings, a Report to California's Sustainable Building task Force, available from: www.usgbc.org/Docs/Archive/MediaArchive/607_kats_AB184.pdf [accessed September 2011].

Kibert, C. J. (2004). Green buildings: an overview of progress, *Journal of Land Use*, *19*, 491-502.

Klitzman, S. & Stellman, J. M. (1989). The impact of the physical environment on the psychological well-being of office workers, *Social Science Medicine, 29*, 733-742.

Knowles, L., MacLean, P., Rosato, M., Stanley, C., Volpe, S. & Yousif, D. (2002). *Living wall, A feasibility study for the SLC,* unpublished thesis, University of Waterloo, Canada.

Lan, L., Wargocki, P., Wyon, D.P. & Lian, Z. (2011). Effects of thermal discomfort in an office on perceived air quality, SBS symptoms, physiological responses, and human performance, *Indoor Air*, *21*, 376-390.

Lee, Y.S. & Kim , S. (2008). Indoor environmental quality in LEED-certified buildings in the U.S, *Journal of Asian Architecture and Building Engineering*, *7*, 293-300.

Leaman, A. & Bordass, B. (1999). Productivity in buildings: the 'killer' variables, *Building Research and Information*, *27*, 4-19.

Leaman, A., Thomas, L. & Vandenberg, M. (2007). 'Green' buildings: what Australian building users are saying, *EcoLibrium*, November, 2-31.

Leslie, R.P. (2003). Capturing the daylight dividend in buildings: why and how, *Building and Environment, 38*, 381-385.

Maller, C., Townsend, M., Pryor, A., Brown, P. & St Leger, L. (2005). Healthy nature healthy people: 'contact with nature' as an upstream health promotion intervention for populations, *Health Promotion International*, *21*, 45-54.

Menzies, D. & Bourbeau, J. (1997). Building-related Illnesses, *The New England Journal of Medicine*, *337*, 1524-1531.

Miller, N.G., Pogue, D., Gough, Q.D. & Davis, S.M. (2009). Green buildings and productivity, *Journal of Sustainable Real Estate*, *1*, 65-89.

Mills, P.R., Tomkins, S.C., & Schlangen, L.(2007). The effect of high correlated colour temperature office lighting on employee wellbeing and work performance. *Journal of Circadian Rhythms, 5*, 1- 9.

Moschandreas, D.J. & Nuanual, R.M. (2008). Do certified sustainable buildings perform better than similar conventional buildings? *International Journal of Environment and Sustainable Development*, *7*, 276-292.

Niemla, R., Seppanen, O., Korhonen, P. & Reijula, K. (2006). Prevalence of building-related symptoms as an indicator of health and productivity, *American Journal of Industrial Medicine, 49*, 819-825.

Oldham, G.R. & Rotchford, N.L. (1983). Relationships between office characteristics and employee reactions: a study of the physical environment, *Administrative Science Quarterly, 28*, 542-556.

Parsons, K. C. (2000). Environmental Ergonomics: a review of principles, methods and models, *Applied Ergonomics, 31*, 581-594.

Paul, W.L. & Taylor, P.A. (2008). A comparison of occupant comfort and satisfaction between a green building and a conventional building, *Building & Environment, 43,*1858-1870.

Pyke, C., McMahon, S. & Dietsche, T. (2010). Green building & human experience, USGBC research program white paper, available from: www.kathyshafferarchitect.com/image/Human%20Experience.pdf [accessed September 2012].

Ries, R.B., Gokhan, M.M., Needy, N.M. & LaScola, K. (2006). The economic benefits of green buildings a comprehensive case study, *Engineering Economist, 51*, 259-295.

Scarpello, V. & Campbell, J.P. (1983). Job satisfaction: are all the parts there, *Personnel Psychology*, *36*, 577-600.

Singh, A., Syal, M., Grady, S.C. & Korkmaz, S. (2010). Effects of green buildings on employee health and productivity, *American Journal of Public Health, 100*, 1665-1668.

Spector, P.E. (1994). Using self-report questionnaires in OB research: A comment on the use of a controversial method, *Journal of Organizational Behavior, 15*, 385-392.

Steemers, K. & Manachanda, S. (2010). Energy efficient design and occupant well-being: case studies in the UK and India, *Building and Environment, 45*, 270-278.

Stewart-Brown, S. & Janmohamed. K. (2006). Warwick-Edinburgh mental well-being scale (WEMWBS) User guide version 1. NHS Health Scotland: University of Warwick & University of Edinburgh.

Sustainability Victoria & Kador Group, Employee productivity in a sustainable building: pre- and post-occupancy studies in 500 Collins Street, 2006, available from: www.resourcesmart.vic.gov.au/.../500_Collins_Productivity_Study.pdf [accessed August 2011].

Swanson, V. & Power, K. (2001). Employees' perceptions of organizational restructuring: the role of social support, *Work & Stress, 15*, 161-178.

Thatcher, A. & Milner, K. (2012). The impact of a 'green' building on employees' physical and psychological wellbeing. *WORK: A Journal of Prevention, Assessment and Rehabilitation, 41*, 3816-3823.

Veitch, J. A., Charles, K.E., Farley, K.M.J. & Newsham, G.R (2007). A model of satisfaction with open-plan office conditions: COPE field findings, *Journal of Environmental Psychology, 27*, 177-189.

Von Paumgartten, P. (2003). The business case for high-performance green buildings: sustainability and its financial impact, *Journal of Facilities Management*, *2*, 26-34.

Wanous, J.P. , Reichers, A.E. & Hudy, M.J. (1997). Overall job satisfaction: how good are single-item measures, *Journal of Applied Psychology*, *82*, 247-252.

Warr, P. (2012). How to think about and measure psychological well-being, available from: www.shef.ac.uk/polopoly-fs/1.157451/file/Warr_pdf_Well-being_Measurement_Chapter.pdf [accessed November 2012].

Welman, C. , Kruger, F. & Mitchell, B. (2005). *Research methodology (third ed.).* Cape Town: Oxford University Press Southern Africa.

Wyon, D. P. (2000). Enhancing productivity while reducing energy use in buildings. Proceedings of the E-Vision 2000 Conference, Washington, D.C October 2000.

Wyon, D.P. (2003). The effects of indoor air quality on performance and productivity, *Indoor Air*, *14*, 92-101.

Appendix 1

Hello,

We are Professors Andrew Thatcher and Karen Milner from the Psychology Department at the University of the Witwatersrand. This study looks at the impact of green buildings on employees work functioning. Nedbank has the first GreenStar accredited building in South Africa and we would like to investigate whether this will have any impact on your well-being and effectiveness at work. You are invited to participate in this study.

Participation in this study will involve completing the following questionnaire which should take approximately 10 minutes now (Time 1) and again in approximately six months time (Time 2). Participation is voluntary, and no one will be advantaged or disadvantaged for choosing to participate or not. There are no direct benefits to participants anticipated from participation in this study. While there is a question asking for your employee number this is to enable us to connect your Time 1 responses to your Time 2 responses and to collect certain biographical information. At no point will we have access to your name or any other identifying information about you other than what you provide us and as such, you will remain anonymous. By completing this survey, you provide consent to the following: That my information and response data will be supplied to third parties, for the purposes of processing, further processing and analysing the information in order to derive reports that will be utilised by The University of the Witwatersrand and by Nedbank to effect improvements to all Nedbank buildings. That the appointed third parties will retain my information and response data (confidentially) for as long as is deemed necessary, in order to provide context and previous responses/information that will allow the trending of perceptions over time.

Your completed surveys will not be seen by anyone other than us (the researchers) and your responses will be saved in a neutral and secure database which is password protected. Thus, your confidentiality is guaranteed. Your responses will only be looked at in relation to all other responses which means that feedback given to Nedbank will be in the form of aggregated responses and not individual perceptions. An executive summary of the results of this study will be made available to you via your organisation. The University also will have the option to publish the aggregate results once the study is complete in a student's research report and/or as a research publication in a journal.

If you choose to participate, please click on the link at the bottom of this page. Submitting your responses will be taken as your consent to participate in this study. You may withdraw from the survey at any point before pressing the submit button by closing the survey.

Your participation in this study would be greatly appreciated. This research will contribute to our understanding of how our built environment contributes to our well-being and effectiveness as employees in organisations.

Best regards,

Andrew Thatcher (andrew.thatcher@wits.ac.za) & Karen Milner (Karen.milner@wits.ac.za)