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The Impact of Office Comfort on Productivity

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Abstract:

Purpose – The aim of this paper is to evaluate the impact that office comfort has on office occupiers' productivity.

Design/methodology/approach – The author evaluates the literature that claims to make a linkage between the physical comfort of the office environment and the effect on the productivity of the office occupiers. Office comfort will initially be discussed as a generic concept and subsequently be broken down into sub-components.

Findings – The review of the literature reveals that the evaluation of office comfort is a complex one. There appears to be no universally accepted definition of office comfort, and there is a clear lack of agreement as to how office comfort should be measured.

Originality/value – This paper establishes that there is enough evidence to support the claim that office comfort can affect productivity. This paper adds to the debate by identifying the need for a common and universally accepted measurement of office comfort. It is proposed that this can largely be achieved by evaluating office comfort with a multi-item scale, and adopting an office occupier perspective to any future research.

Keywords: Workplace, Office productivity, Office evaluation, Office comfort

Paper Type: Literature Review

Introduction

This paper aims to review the literature that claims to link the comfort of the office environment to the productivity of its occupants. Whilst the general concept of comfort will be addressed, specific attention will be given to the air quality, sick building syndrome and lighting.

Office comfort

Office evaluations have traditionally been Post Occupancy Evaluation (POE) surveys that assess how satisfied occupiers are with their working environments (McDougall *et al*, 2002). However, whilst this form of survey establishes an assessment of the quality of environment, it does not establish if the environment

affects the occupiers' productivity. Leaman (1990) presented the idea that a possible relationship exists between the quality of the office environment and the productivity of its occupiers. Subsequently, Leaman (1995) adopted a survey method, in an attempt to establish if the occupiers who were dissatisfied with their indoor environmental conditions were also less productive in their work. He concluded that:

> *"People who are unhappy with temperature, air quality, lighting and noise conditions in their offices are more likely to say that this affects their productivity at work." (Leaman, 1995, p13)*

The questionnaire adopted consisted of eight main sections.

Table:1 Survey questions (Leaman ,1995)

Survey Questions	
Environmental Comfort	36 questions
Health Symptoms	10 questions
Satisfaction with amenities	5-15 questions
Time spent in building	1 question
Time spent at task	1 question
Productivity	1-3 questions
Perceived control	5 questions
Background data	3-10 questions

The measure of productivity was achieved by adopting a self-reported measure, presented in a nine-point scale ranging from <-40% to >+ 40% (loss/gain), based on the question:

> *“Does your office environment affect your productivity at work? “(Leaman, 1995, p16)*

Leaman (1995) suggests that a correlation exists ($r = 0.92$), between people who report dissatisfaction with their indoor environment and those that report the office environment to be affecting their productivity; and the finding is reported to be significant ($p = 0.0034$). However, Leaman (1995) acknowledges that no statistical association exists between self-reported productivity and satisfaction with the office environmental conditions. These results must be interpreted with care, as correlation between variables does not prove causality. Moreover, the self–reported productivity measure adopted only consists of a single question.

Whereas Leaman (1995) could only offer support for a relationship between dissatisfaction and productivity, Oseland & Bartlett (1999) evaluated occupiers

across ten office buildings and reported a correlation between productivity and satisfaction (0.93< r <0.99). They acknowledge that the high correlation could be partly explained by the way the questions were asked:

> *"Considering the effect on your performance, how satisfied are you with the office facilities and services?" (Oseland & Bartlett, 1999, p92)*

One of the key findings from Leaman's (1995) analysis is that people's perception of their ability to control their own working environment is reported as being an important element of their productivity. This is a result supported by Oseland & Bartlett (1999), claiming that a correlation exists between perceived control over environmental conditions and productivity (r = 0.49).

An interesting concept put forward by Leaman (1995) is "forgiveness". This relates to how forgiving the occupants are of the shortcomings of the building. It is proposed that "forgiveness" can be increased if the occupants:

> *"Know that every effort is made to overcome them, and they will usually tolerate problems which they understand are hard to solve" (Leaman, 1995, p150)*

Establishing the factors that should be included when assessing the office environment is a complex area, although Oseland (1999) concluded, having undertaken an extensive literature review, that occupiers' satisfaction with their environment, i.e. how comfortable they were, was instrumental in their productivity levels. Oseland (1999) establishes that comfort with the environment includes both physiological and psychological components as well as the physical environmental conditions.[i]

Table:2 Components of environmental satisfaction (Oseland, 1999)

	Environmental Satisfaction (Comfort)
Environmental Conditions	Physical Conditions, Space, Ergonomics, Aesthetics
Physiology	Gender, Age, Ethnic Group
Psychology	Personality, Expectations, Experience, etc

Although Oseland (1999) acknowledges the role of physiological and psychological components in office occupiers' productivity, the review largely concentrates on the environmental conditions of the office environment, which are broken down as follows:

Table:3 Elements of environmental conditions (Oseland, 1999)

	Environmental Conditions
Physical Conditions	Temperature, Light, Noise, air quality etc
Space	Plan, Layout, Privacy
Ergonomics	Work-station, Controls
Aesthetics	Colour, Quality

The breaking down of the environmental conditions into four dimensions is a useful way of operationalising the concept of the physical environment. Although it could be argued, that the behavioural component of the office environment is not identified (Haynes, 2005).

The debate relating to the use of occupier satisfaction with the office environment as a surrogate measure of office productivity has been developed by Fitch (2004). He adds to the debate with an evaluation of serviced office environments, and claims that a relationship exists between satisfaction with the office environment and the reported productivity levels of the office occupiers (Fitch, 2004). Clark *et al* (2004) attempt to present a unifying model that links building performance, user satisfaction and self-reported productivity techniques. As a general model communalities exist between the three areas, however on a detailed level the different techniques provided specific detail that would have been lost in a totally unified model of evaluation (Clark *et al,* 2004), and this therefore demonstrates the benefits of different approaches. The challenge to find a validated method of measuring and reporting office productivity remains to be achieved, with some authors referring to this area of research as the *"search for the Holy Grail"* (Mawson, 2002).

Leaman & Bordass (2000), in their seminal work, aim to address the question "*What features of workplaces under the control of designers and managers significantly influence human productivity*". This is an appropriate stance as it puts delimitations on the research, concentrating on areas that can be directly affected by designers or facilities managers, and therefore does not attempt to address issues such as stress, management attitudes and job satisfaction. In this work Leaman & Bordass (2000) use the term "killer" variables, which are defined as variables having a "*critical influence on the overall behaviour of a system*" (Leaman & Bordass, 2000, p171).

The "killer" variables are arranged into five clusters. The clusters are: personal control, responsiveness, building depth, work groups (Leaman & Bordass, 2000) and design intent (Leaman & Bordass, 2005). Each cluster will now be discussed.

Personal Control

Leaman & Bordass (2000) present results from 11 UK buildings, and claim that 7 out of the 11 buildings had a significant association between self-assessed productivity and perception of control. Leaman & Bordass (2000) develop this claim by stating that in their research the lack of environmental control is the single most important concern for office occupiers. This finding is supported by Whitley *et al* (1996), who identified people that have an internal *"locus of control",*

feel productive when they perceive they have control over their physical environment.

Responsiveness

The responsiveness dimension relates to how quickly the Facilities Management (FM) team can respond to a complaint about their environment. This probably links back to Leaman's earlier work, which established the "forgiving" nature of people. If office occupiers are kept informed of events relating to their environmental comfort, then they are more likely to be more responsive and forgiving (Leaman, 1995).

Building Depth

Leaman & Bordass (2000) present evidence that air-conditioned buildings (usually, but not always deeper than 15m) have a more negative effect on perceived productivity than naturally ventilated buildings (less than 15 m across). The connection is made between increased dependency on environmental systems, such as air-conditioning, and ill health symptoms.

Work Groups

In evaluating the fourth cluster of variables, which relates to workgroups, Leaman & Bordass (2000) acknowledge that they have only been able to get both productivity and workgroup data on rare occasions. However they maintain:

> *"That perceptions of productivity are higher in smaller more integrated workgroups" (Leaman & Bordass, 2000, p183)*

Other researchers have proposed that a relationship exists between the number of people working together, and their corresponding productivity levels (Olson, 2002; Fitch, 2004). Olson (2002) ultimately concludes that productivity improvements can be achieved by moving away from open-plan environments, and back to more private cellular type offices.

Design Intent

Leaman & Bordass (2005) have added another "killer" variable, which they call design intent. This relates to the potential mismatch between the design intention of an office environment and the actual use of the office environment. This means that there is a greater emphasis placed on the designer to clearly communicate their vision of how the office space is to be used. In addition, designers should aim to design office environments to be as intuitive as possible. To ensure that the optimum work environment is created, consideration needs to be given to the range of occupiers' work activities (Haynes, 2007a). Clearly this is an area that requires further research.

Leaman & Bordass (2005) conclude that offices work best for human productivity when:

i) There are opportunities for personal control

ii) There is a rapid response to environmental issues

iii) There are shallow plan forms, preferably with natural ventilation and less technical and management-intensive systems

iv) Enough room for people to work in, and appropriate zoning and control of heating, cooling, lighting and ventilation.

v) Office occupiers are given clear instruction of the design intent. Occupiers are shown how things are intended to work. In addition any changes are rapidly communicated to the occupiers.

Support for improved FM, as a means of increasing office productivity, is presented by Clements-Croome (2003). He maintains that both greater energy savings and increases in productivity can be achieved by ensuring that healthy buildings are produced. He also acknowledges that it is not just the design and construction of the building, but also the way the building is managed through its FM provision that can impact on occupier productivity. Clements-Croome, (2003) identifies that the most frequent complaints relate to thermal problems, stuffiness, sick building syndrome and crowding. It is therefore suggested that by improving the office environmental conditions, occupier productivity could be increased by 4-10%.

The Office Productivity Network (OPN) assesses office productivity with two occupant feedback tools. The tools proposed are the *OPN Survey* and the *OPN Index* (Oseland, 2004). The OPN survey is a questionnaire that can be administered in both paper and web based formats. Oseland (2004) reports to have administered the questionnaire in 60 buildings and has over 6,500 responses.[ii] Whilst the office occupiers complete the *OPN Survey*, the data collected for the *OPN Index* is established by interview with selected staff using an interview pro-forma, since knowledge of the building design and operation is required[iii].

The *OPN Survey* consists of a number of sections and can be seen below (Oseland, 2004):

- *Satisfaction with Facilities* - 19 questions enquiring whether the respondents are satisfied with how the various design and operational factors (e.g. workspace, meeting areas, technology) support their work activities; note that although the question asks the respondents to rate

their satisfaction, the emphasis is actually on supporting work activities which relate to productivity;

- *Satisfaction with Environment* - 15 questions asking whether the respondents are satisfied with how the environmental conditions (e.g. temperature, noise, privacy) support their work activities;

- *Importance* - 2 questions which ask the respondents to identify which of the facilities and environmental conditions they consider the most important to "get right" so that they can work well;

- *Self-assessed Productivity* - 2 questions, which ask respondents to estimate the impact of the facilities and environment on their productivity;

- *Downtime* - 18 questions which ask the respondents to estimate the amount of time per week wasted due to a range of poor design and operational issues; these questions were developed as a direct result of feedback during the focus groups;

- *Satisfaction with Work Activities* - 11 questions asking whether the facilities and environment support various work activities (e.g. quiet work, teamwork, meeting deadlines);

- *Work Duties* - 12 questions to estimate the time spent carrying out the various work activities (e.g. PC work, telephone usage, formal meetings);

- *Work Time* - 7 questions to estimate the time spent working in and out of the office;

- *Background Details* - Questions to identify sub-groups whose responses to the above questions may be compared (e.g. grade, location in building, business unit).

Oseland (2004) includes two questions specifically relating to productivity. One relates to the facilities and productivity, and the other relates to the environment and productivity. Oseland (2004) adopts the same nine-point scale for self-assessment of productivity as Leaman (1995) and Leaman & Bordass (2000). However in contrast to Leaman (1995) and Leaman & Bordass (2000), Oseland (2004) evaluates the facilities as well as the environment. It could be argued that this is an improvement in measuring productivity, i.e. from one question on productivity to two questions, although it does not allow the subcomponent of facilities and environment to be evaluated with regards to productivity. In analysing the data, see figure 1, Oseland (2004) proposes, using multiple regression analysis (weighted means), that change in productivity and overall satisfaction with the environment and facilities are highly correlated, i.e. facilities ($r = 0.94$) and environment ($r = 0.91$).

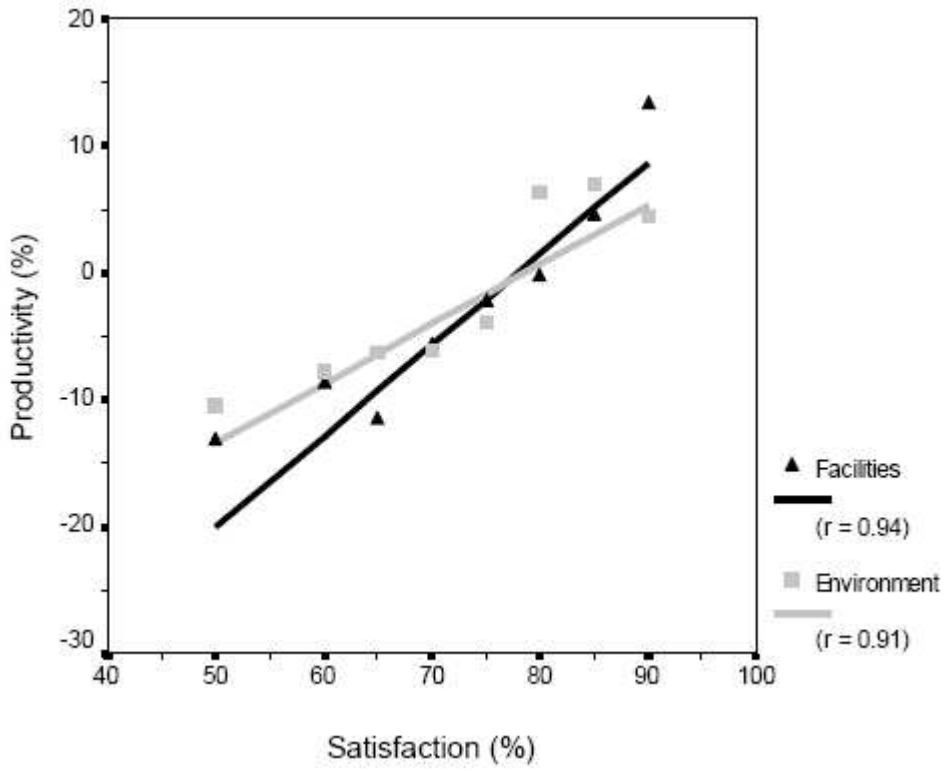

Figure.1 Correlation between productivity and satisfaction (Oseland, 2004)

The concept "downtime" is introduced and defined as effectively time wasted due to poor design and management of the office environment. Oseland (2004) presents evidence, see figure 2, to suggest negative correlations between downtime and satisfaction with the environment and facilities, i.e. facilities (r = 0.69) and environment (r = 0.78). The more time wasted due to poor office design and management the more dissatisfied the occupiers are with their office environment. Some of the downtime elements defined by Oseland (2004), i.e. waiting for lifts, walking between buildings, interruptions, waiting at fax & copier machines, could actually be opportunities for ad hoc conversations and knowledge transfer (Haynes 2005).

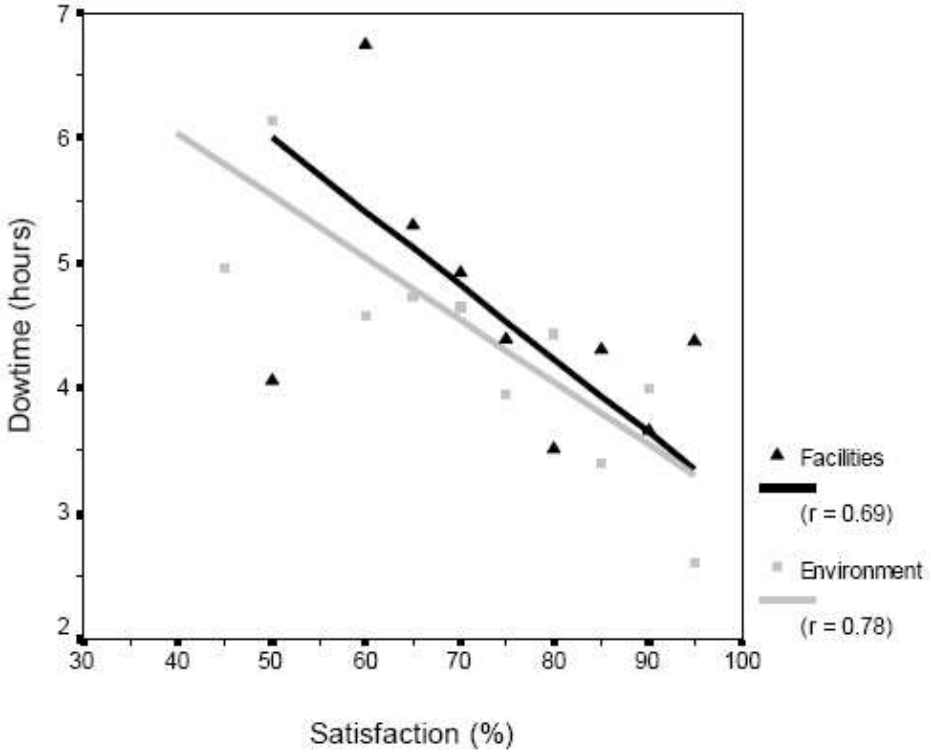

Figure.2 Correlation between downtime and satisfaction (Oseland, 2004)

The conclusions that Oseland (2004) draws from the analysis of the database, is that office occupiers are mainly dissatisfied with temperature and ventilation, commonly called the "hygiene factors". An explanation offered for this is the requirement for more individual control, an issue previously acknowledged by Leaman & Bordass (2000). Also since the results evaluated are largely from open-plan offices, it could also be concluded that the disadvantages of open-plan environments are not really being addressed (Oseland, 2004).

Finally, Oseland (2004) concludes that:

> *"The environmental conditions which are considered most important to "get right" to support the respondents' work activities are: winter and summer temperature, ventilation, people noise, privacy and daylight" (Oseland, 2004, p7)*

Roelofsen (2002) drew similar conclusions to Oseland (2004), having undertaken a review of the literature pertaining to the impact of office environments on employee performance. He concluded that in the office environment it was the thermal environment (temperature) and the air quality (ventilation) that had the most influence on people's productivity Roelofsen (2002) calls for a validated unifying human model, which allows the concept of comfort, i.e. temperature and

air quality, to be evaluated in terms of loss of productivity. Haynes (2007b) responds to the call for a unifying human model by presenting a validated theoretical framework for office productivity, which includes a multi-item scale measurement of office comfort.

Whilst authors such as Oseland (2004) and Leaman & Bordass (2005), have attempted to evaluate occupier satisfaction against a range of environmental and facility issues; other authors have attempted to restrict their evaluation to one specific component and its effect on productivity. The following sections will review these specific pieces of research.

Air Quality

Dorgan & Dorgan (2005) argue that, due to the amount of time that employees spend in their offices, it is important to ensure that the indoor environment is of an appropriate quality. They propose that a linkage exists between the quality of the environment and the health and productivity of the occupants. They attempt to establish the appropriate components of the environment.

> *"The indoor environmental quality (IEQ) is composed of factors such as space, temperature, humidity, noise, lighting, interior design and layout, building envelope, and structural systems. A subset of the IEQ is indoor air quality (IAQ). The factors that define IAQ are temperature, humidity, room air motion and contaminants." (Dorgan & Dorgan, 2005, p113)*

Dorgan and Dorgan (2005) maintain that if the Indoor Air Quality (IAQ) is not at the right level, then there will be an impact on the occupant's health and productivity. They base their proposals on three studies, funded by the National Contractors' Association, which investigated the health costs and productivity benefits of Improved Air Quality. The original study was undertaken in 1993, and was further developed in 1995. The third study was restricted to the hospitality industry. The studies concentrated on reviewing over 500 research reports that attempted to link IAQ and productivity. Ultimately, Dorgan and Dorgan (2005) conclude their review by establishing:

> *"A majority of the research studies indicate an average productivity loss of 10 percent due to poor IAQ. Therefore, by improving the IAQ, a conservative benefit of 6 percent could readily be achieved." (Dorgan & Dorgan, 2005, p 128)*

Dorgan and Dorgan (2005) argue that whilst most of the IAQ research has focused on offices and schools, IAQ has potentially a greater impact on hospitality facilities and workers. The additional factors to be included are;

cooking, high density of people in halls, bars, restaurants and potentially a higher proportion of people smoking.

In an attempt to quantify the effect IAQ has on productivity Wargocki *et al* (2000a) adopted a traditional experimental approach to three independent studies including 90 subjects. The change of air quality was established by interventions, and the effects on the occupiers were assessed using a perceived air quality acceptability scale. The productivity measures adopted were measurable, i.e. not self-reported, since the activities undertaken in the office were simulated office tasks such as typing, addition and proof-reading. Wargocki *et al* (2000a) concluded that a relationship exits between good air quality and office productivity.

> *"It confirms that good air quality improves the performance of text typing (P=0.0002), and a similar tendency is seen for addition (P=0.056) and proof-reading (P=0.087). A positive correlation between the air quality, as it is perceived by occupants, and the performance of typing (R2=0.82, P=0.005), addition (R2=0.52, P=0.07) and proof-reading (R2=0.70, P=0.08)." (Wargocki et al, 2000a, p635)*

It could be argued that one limitation of the results presented by Wargocki *et al* (2000a) is that they only relate to repetitive tasks, such as typing, addition and proof-reading. Wyon and Wargocki (2005) evaluate two field intervention experiments in call centres in an attempt to validate previous laboratory experiments. The field research evaluated consisted of a call centre in Denmark - a temperature climate (Wargocki *et al,* 2004) and a call centre in Singapore - a tropical climate (Tham *et al,* 2003). Both studies adopted a 2x2 design with one repetition over 8 weeks, each condition being maintained for a full week. In addition both studies adopted talk-time as an index for productivity. A reduction in talk-time was deemed to be an indication of improved productivity. Wyon and Wargocki (2005) conclude that the field studies evaluated demonstrate that indoor air quality has a larger impact on actual productivity in the call centres than was predicted in previous laboratory experiments.

Developing research in the field is to be encouraged as this allows research to be developed in its true context. However, not all office workers have a clear productivity measure like the call centre workers. Some offices are places of knowledge exchange, with people constantly moving around. In this context the issue of providing appropriate IAQ becomes a more complex one (Laing *et al*, 1998, Haynes, 2005).

Establishing the thermal comfort of office occupants is a challenging area. This is compounded by the fact that human beings produce a range of heat output which is dependent on variables such as; amount of clothing they are wearing, the activity they undertake in the office and a number of other extraneous variables (Dwyer, 2006). Dwyer (2006) accredits Ole Fanger's work relating to predicted mean vote (PMV) and percentage population dissatisfied (PPD), as being

fundamental to the development of standards such as ISO 7730 and the ASHRAE Standard 55. The PMV can be used to predict the percentage of people dissatisfied with the thermal comfort in their office environment. The thermal comfort is deemed to be a success if 80% of occupants are comfortable in their office environments (Dwyer, 2006). Clearly, with potentially 20% of office occupiers dissatisfied with their thermal comfort this is an area that requires continuing research.

Health: Sick Building Syndrome

An attempt to broaden the debate with regard to office evaluation was undertaken by Whitley*, et al* (1996). They proposed that occupiers' satisfaction with the indoor environment could be influenced by the climate of the organisation and the occupiers' satisfaction with their jobs. Their research aimed to investigate Sick Building Syndrome (SBS), and its effects on occupiers, both in terms of health and productivity. They collected over 400 responses from two buildings. An occupational and organisational psychology questionnaire was adopted to assess job satisfaction, organisational climate and job characteristics. The environmental satisfaction was assessed using a seven-point user perception scale. Productivity was self-reported, using a perceived productivity scale. It is interesting to note that the self-assessed productivity scale adopted, with slight modification, was the same one originally proposed by Leaman (1995) and subsequently adopted by Oseland (1999 &2004).

Whitley *et al* (1996) concluded that:

> *"Office satisfaction is seen as a primary predictor of sick building syndrome and self-reported productivity. Office satisfaction is significantly associated with job satisfaction and environmental control." (Whitely et al, 1996, p5)*

Whilst this research adds to the debate by acknowledging that the office environment is more than just the physical comfort elements, and alludes to a behavioural environment which links to organisational culture, the limitations of the research must be acknowledged. Firstly the research was undertaken between two buildings in the same organisation, therefore the possibility of generalisation is reduced, and secondly the measure of productivity adopted is only a single item self-assessed scale.

Wargocki *et al* (2000b) attempted to evaluate the effects of outdoor air supply rate on perceived air quality, SBS and productivity. The evaluations were conducted in a normally furnished office.

> *"Five groups of six female subjects were each exposed to three ventilations rates, one group and one ventilation rate at a time. Each exposure lasted 4.6 h and took place in the afternoon." (Wargocki et al, 2000b, p222)*

The subjects were assessed, at intervals, for perceived air quality and SBS symptoms and evaluated whilst performing simulated office work. The results indicate that when ventilation was increased the subjects reported feeling generally better ($P<0.001$). Also, for all the simulated work tasks, such as addition, text typing, proof-reading and creative thinking, improvements were reported with increases in the ventilation, and in the case of text-typing the results reached significance ($P<0.03$). The inclusion of the creative thinking component into the assessment of simulated office tasks is an improvement in modelling the work processes of the modern office (Wargocki *et al,* 2000b). Since creative thinking is one of the main assets of the modern office environment, the results suggest that increased ventilation leads to the subjects reporting less difficulty in thinking ($P < 0.001$). Therefore the ventilation requirements of the office occupiers become an important ingredient in creating a productive workplace. Whilst the rigour of the research conducted by Wargocki *at al* (2000b) is acknowledged, a limitation is that the evaluation was undertaken in one office environment, therefore generalising the results would be questionable. Also the subjects used were female and therefore may include a gender bias.

Lighting

Abdou (1997) suggests that significant improvement in office lighting can be a cost-effective way of increasing productivity. He maintains that office occupiers believe that lighting is an important aspect of their office environment, with daylight being of particular importance. Support for linking day lighting to human performance is presented by Heschong *et al* (2002). They present a re-evaluation of a previous piece of research to investigate the effects of day lighting on the grades of children in schools. The research concluded that a statistical relationship existed between students access to daylight and student performance. Daylight was assessed using a five-point scale (0 = non-existent to 5 = highest quality of daylight). To establish the performance metric, only students that were exposed to highly standardised tests were used, including students from second to fifth grade in elementary schools. Whilst this research relates to improvement in grades of children, it is similar to the evaluation of office productivity, as the aim of both is to enhance human performance.

> *"If day lighting enhances the performance of children in schools, it is not too large a stretch to suppose that it might also enhance the performance of adults in office buildings or other workplace settings." (Heschong & Wight, 2002, p 8.91)*

Given a choice it appears that people prefer to have natural lighting in their workplace rather than electric lighting (Veitch, 2005). Veitch (2005) proposes that people who have access to a window are more satisfied with their lighting than the people who do not have access to a window.

Veitch (2005) proposes that the lack of research, by psychologists, in lighting and performance was probably a consequence of the Hawthorne experiments relating

to illumination (Roethlisberger & Dickson, 1939). The Hawthorne illumination experiments demonstrated that irrespective of increasing or decreasing lighting levels, the work output of the employees increased. The conclusion drawn by the investigators was that the physical environment was relatively unimportant when considering productivity improvements (Roethlisberger & Dickson, 1939). Veitch (2005) therefore suggests that the research that has been undertaken tends to evaluate lighting in economic terms rather than from the human perspective.

Boyce *et al* (2003) conducted a field simulation study to investigate lighting quality and office work. The study consisted of two separate field simulations and in both cases "Best Practice" office lighting conditions were compared with a "Base Case" lighting condition that was thought to be representative of modern office practice. The office occupiers' task performance was measured, and their perceptions of health and well-being were obtained over a full working day.

Boyce *et al* (2003) established that people's preference for lighting conditions are wide ranging. This result clearly indicates that one set lighting level in an open plan office environment is not going to satisfy all of its occupants.

Veitch (2005) supports the need for individual control.

> *"Individual lighting controls can address the problem of individual differences in lighting preferences. When one does not know which conditions will create positive affect, individual controls allow people to self-select their preferred conditions." (Veitch, 2005, p 213)*

This need for people to feel they have control of their environment links to the *"locus of control"* proposed by Whitley *et al* (1996), and one of the *"killer variables"* proposed by Leaman & Bordass (2005).

Boyce *et al* (2003) conclude that:

> *"People with dimming control report higher ratings of lighting quality, overall environmental satisfaction, and self-reported productivity." (Boyce et al, 2003, p4)*

An advantage of the study undertaken by Boyce *et al* (2003) is that it is in an actual office environment with office workers undertaking real office tasks, specifically knowledge-based tasks. However, a limitation of the study is that the research is restricted to only two field simulations. An additional limitation is that whilst the office workers undertook office work, they were only temporary office workers and therefore the office environment was not their normal work environment. It should also be noted that the evaluations were undertaken over a complete working day, and the results should be interpreted within this context. Further research over a longer period of time would increase the reliability of the research findings.

Veitch (2005) acknowledges that linking lighting to improved organisational productivity is a challenging one. Therefore, Veitch (2005) identifies a requirement to develop a lighting quality model that acknowledges the economic and architectural requirements for lighting, but also identifies a need for lighting to influence social behaviour, communication, mood and ultimately individual well-being. It is these later elements that offer opportunities for further research (Haynes, 2007c).

In Conclusion

This paper has reviewed literature that addresses the physiological elements in the office environment. The aim was to evaluate claims that productivity is affected when office occupiers are not physically comfortable in their office environment. Defining the term office comfort is a complex area in its own right, as there are a number of different variables that could impact on office occupiers' comfort levels. A review of the literature reveals that there does not appear to be a unifying model of office comfort, evidenced by the different approaches adopted by researchers to measuring office comfort. Whilst an agreed definition of office comfort does not appear to exist, there are clearly some common variables that should be included in the concept of office comfort; such as temperature, air quality and lighting. Future research that attempts to create a unifying model would be a considerable development, as it would allow the creation of a multi-item measure of office comfort, which could include variables such as noise, humidity and crowding. A possible analytical approach for such a model could be factor analysis (Haynes, 2007b).

Each of the research approaches evaluated have advantages and disadvantages. There appear to be three different approaches adopted with regards to measuring office occupiers' productivity, which are: measurement of simulated tasks, measurement of actual productivity output, or self-assessed measurement of productivity. The measurement of simulated tasks is normally undertaken over a short period of time and therefore raises concerns of reliability over a longer period. Actual measurements of productivity are clearly the most desirable, although not all types of office work can be easily classified into productive output. Call centres appear to be a notable exception. The complexity of measuring the productivity of office workers has led some researchers to adopt occupier satisfaction with the office environment as a surrogate for productivity. This approach needs to be considered with care; whilst there is evidence to suggest a correlation between productivity and satisfaction exists, it raises issues of research validity. Increased research validly can be achieved if the research includes measurement of the actual variables under investigation. It could therefore be argued that in the absence of a quantifiable productivity measurement, a self-assessed measure is a justifiable consideration.

The context in which research is undertaken is a very important factor. Clearly simulated tasks undertaken in laboratory type conditions have a value during the early stages of research, as they allow the researcher to develop their ideas and thinking. However, if increased validity is to be achieved then research has to be

undertaken in the field. The ultimate in research design would be actual office workers, working in their normal office environment, undertaking real office tasks evaluated with a quantifiable measurement of office productivity. Add to this research that analyses different office environments with occupiers undertaking different office work, and an appreciation for the scale of research required can be achieved.

This does not mean that small-scale research projects do not have a role in establishing meaning and understanding in office environments. In fact it is probably this approach that would lead to the identification of the variables that should be included in a unifying model. Since office comfort is a relative term it is clear that any research methodology should include a “people-centric” approach to evaluate user perceptions, along with any other observations and measurements. Taking the view of the office environment from the occupier perspective opens up an appreciation of office comfort to include concepts such as health and well-being.

It is clear that the FM profession can have a significant impact in creating high performance workplaces by placing greater emphasis on office environment comfort systems and their respective control systems. In addition keeping office occupiers informed of any issues that affect their comfort can be an important element in managing office user perceptions. The managing of office occupier expectations offers another avenue for further research, as it allows the concept of occupier *“forgiveness”* to be evaluated with the aim of establishing appropriate protocols and communication channels.

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[i] It should be noted that Oseland (1999) actually proposes a broader theoretical framework for the evaluation of performance and productivity. He includes the concepts of job satisfaction and motivation. However this analysis will concentrate on the environmental components.

[ii] The size of this database would make it probably one of the largest that relates to occupier productivity.

[iii] Oseland (2004) reports to have data for 20 buildings using the *OPN Index*.