PRODUCTIVE AND HEALTHY WORKPLACES: A LITERATURE REVIEW

1.0 Introduction

For much of the 1990s and 2000s, the focus of workplace planning was on improving the efficiency of occupation: getting more from less. At the same time, technology-enabled agile working spread rapidly as organisations and individuals recognised the benefits of team work and collaboration, and as networks and connectivity replaced the ossified structures of much corporate life.

More recently, the agenda has moved subtly, towards one focused on improving productivity and wellbeing in the workplace. This paper seeks to connect workplace practitioners caught up in the day-to-day activities with an overview of the main strands of this new agenda to inform their decision-making.

2.0 Why productivity and wellbeing are important

The UK economy has been suffering a slowdown in productivity since the Global Financial Crisis in 2008. According to Weldon (2016), from the early-1970s to 2008, productivity grew by around 2% per annum; but since 2009, the economy has flatlined. The UK's productivity is now around 18% below the average for the other members of the Group of Seven advanced economies. Moreover, Weldon points out that a 1% improvement across the economy could add c£20bn to national output – sufficient to reduce the annual deficit by £8bn.

Around ten million UK workers, a third of the total workforce, are employed in offices. It therefore follows that if productivity gains can be made there, then they will help ease a national problem. And there is clearly an opportunity to do so. Economist Roger Bootle argued that UK businesses were wasting up to £18bn annually through inefficient use of property, and that new working practices could save business £6.5bn annually (Bootle, 2002).

Then there is wellbeing. The workplace cannot, of itself, determine wellbeing, but it can be a contributory factor. To work at their best, peoples' physiological and psychological states need to be nurtured. However, it is often the case that poor design and environmental conditions have a negative impact. Added to this, today's workforce is far more diverse (in terms of age, gender and culture) than at any time in the past, and workers demand choice and flexibility in how they work; they require greater connectivity and knowledge sharing, and they require amenities and services to support their wellbeing.

It is widely accepted that the costs of work related stress and illness are growing, and yet very little attention is afforded the place where many people spend the majority of their waking hours: the workplace. Designing the workplace to support people's wellbeing makes business sense: even a modest improvement in employee wellbeing can have a financial implication for employers that is many times larger than savings associated with property costs.

3.0 Context

The impact of the workplace on people and productivity can be traced back over a hundred years, to the Frederick Taylor's seminal *Principles of Scientific Management* (Taylor, 1911). His work influenced management thinking, both in the factory and the office, for nearly a century. While at the Midvale Steel Company, Taylor studied industrial productivity and methods for measuring output. He introduced piecework,

developing systems to maximise the efficiency of men and machines in the factory. His work involved time and motion studies, and his basic thesis was that incentive-based wages were ineffective unless they were used alongside carefully planned and managed tasks, backed up by supportive and co-operative management. He argued for the careful selection and development of people, identifying goals and tasks, organising feedback, training and group support. Scientific management was born.

The Hawthorne experiments of the 1920s and 1930s are also frequently cited in the lineage of thinking on productivity. Also taking place in a factory setting – Western Electric's Hawthorne plant, near Chicago – the work initially investigated the effect of lighting on worker productivity, finding a direct correlation between lighting conditions and output. Researchers led by Elton Mayo concluded that the change in productivity had less to do with the lighting levels themselves, and more to do with the fact that workers' interests were being attended to, which had a motivating effect. The Hawthorne Experiments have been challenged over the years, but it is generally accepted that the work highlighted the positive impact of social factors such as management interest, group work, control over the work environment and methods of working on productivity.

For around three decades following the last war, the workplace changed little, but work certainly did. Most significant was the decline of manufacturing and the rise of service, or office-based activities. As offices and the nature of office work evolved, so new approaches were sought to interior, or workplace, design. One visible symptom was the spread of the open plan office during the 1970s. As noted by Thompson & Kay (2008), the designer and investor Robert Propst foresaw that "*the growing complexity of office work, accompanied by growing numbers of office workers, was awakening interest and concern about office productivity*", and was concerned to discover how workers could "*become more efficient and effective simultaneously*" and how the workplace itself could "*become more responsive to knowledge workers and their work*". The result of his endeavour was Herman Miller's open plan office system, the 'Action Office', introduced in 1968.

Open plan offices, often referred to by designers as 'burolandschaft', were thought to improve internal communications and interaction (Bedoir, 1979; Brunia *et al*, 2016). Of course, they also helped office managers by enabling faster and cheaper reconfiguration of space and people. They were also more efficient in terms of increasing occupancy densities, bringing about real estate cost savings. But the rush to work in open plan came with hidden costs – what we would refer to today as productivity costs.

It is also clear that different cultures responded to open plan in different ways. Van Meel's excellent study of cultural influences on layout referred to the "*hierarchic character of British culture*", the stereotypical image of the British being "*that they are very class-conscious*", which is "*reflected in the culture of their organisations*", helping to "*explain why managers are accommodated in cellular offices and their employees in open plan*" (van Meel, 2000).

While open plan offices changed the way offices looked, this was as nothing compared to the revolution, starting in the late-1980s, with the introduction of office technology. Thirty years is little more than half a contemporary working life. Yet, recalling some of the office technology events of 1987 reveals just how much has changed in such a relatively short time span. Important launches that year included: Windows 2.0; IBM's

PS/2 with 3.5-inch diskette drive; the MAC SE; the Sinclair Z88 portable computer, and the apple.com domain.

4.0 The rise of technologically-enabled work

The technological revolution was a fundamental part of economic re-structuring over the past three decades, which resulted in an enormous growth in 'knowledge workers'. Peter Drucker (1992) predicted that the traditional factors of production – land, labour and capital – would become secondary to knowledge. Today, around a third of the workforce in advanced economies is office-based; employed by businesses that largely trade in the less tangible "knowledge economy". Fewer and fewer businesses own physical assets: short-term leases are replacing long leaseholds and freeholds; and capital-intensive plant has yielded to rapidly depreciated and quickly obsolete desk-top equipment. As a consequence, the single greatest asset (and cost) for most organisations today is their people.

Technological change and corporate change have provided a different prism through which to view office work itself. Indeed, by the early-1990s, the phrase "new ways of working" was established as a catch-all term for workstyles that were increasingly influenced by enabling technologies. At the heart of much thinking was the message that information technology would have a profound impact on the design, management and occupation of buildings in coming years – as, indeed, it has.

As early as 1985, a Harvard Business Review article was particularly prescient in its claims for the unfolding impact of technology on the nature of work. Stone & Luchetti (1985) called their article: *Your Office is Where You Are*, and they set out to "*challenge the customary ways of thinking about offices"* and to show how managers could *"integrate physical layout, design, and communications to support organizational objectives* …". These objectives were to emphasise informal exchange; assign people to different work teams and study groups; provide employees with access to specialist equipment; value individual initiative and mobility; derive payoffs from serendipity; attract talented employees and increase productivity while reducing office costs.

Stone and Luchetti proposed that managers should rethink how both information and people flow in an office, and adopt 'activity settings' to provide a richer experience, with appropriate environments to suit the work in hand. Such thinking contrasted with the command and control systems that had been so dominant for so long. It was holistic, it was purposeful and it recognised technology as an enabler, not a driver. The newly emerging corporate real estate management profession started to recognise the growing implications of organisational and technological change for the delivery of support services to enable new organisational structures and new patterns of work.

It should also be recognised that thinking at this time, in the mid-1990s, was not just about the relationship between the worker and the workplace, but also about that between the workplace and the organisation (van Ree, 2002). Typical of this work was Akinori *et al* (1993) who referred to a new and strong focus on what corporate real estate was contributing to a company's bottom line or what value it was adding to the organisation. In other words, how does real estate and workplace management contribute to better products or services? How does it help the company focus on its core competencies? What does real estate have to do with staff productivity? There is no doubt however that these wider concerns were influenced and directly related to the cost-cutting agenda of the 1990s (Brunia *et al*, 2016).

By the mid-1990s there existed a burgeoning library of reference material outlining the implications of the changing workplace, including: Duffy *et al* (1993); Duffy & Powell (1996); Duffy & Tanis (1993); Pelegrin-Genel (1996); Raymond & Cunliffe (1997) and Worthington (1997). Increasingly, work was seen to be about enabling people to interact and collaborate, underlying the wider macro-economic shift from process labour to knowledge work. In doing so, the office was expected to provide a much richer palette of settings in which individuals and groups could work in a far more dynamic fashion compared with much of the sedentary work of the past.

Implicit in all of this was that workers would become more mobile, or agile, choosing where and when to work. Increasingly the office was becoming less a place to go to work largely alone on a set of prescribed tasks, and more a place to visit and interact with colleagues and use support services. Cairncross (1997) argued that the "*office will become a place for the social aspects of work, such as celebrating, networking, lunching and gossiping*". To cope with this shift in emphasis, office environments would have to be designed the enable increasingly complex relationships to flourish.

One of the earliest examples of agile working in the corporate sector was that introduced by IBM at Bedfont Lakes, near Heathrow in 1992. On moving in, IBM had 600 'SMART' workers who used the office as a base, but had no fixed, personal space. This was one of the earliest examples in the UK of *free addressing*, where personal space is given up and staff use those desks that are available. Each worker was equipped with a portable PC for use at home or in clients' premises.

Coopers and Lybrand (now PWC) moved into its new headquarters at Embankment Place in London in 1992. Eager to maximise the use of the space and at the same time support the working needs of its highly mobile, professional staff, the firm introduced a radical approach to new ways of working, which it trademarked as 'Right Space', to house 1,000 consultants. The objectives of the exercise were: to provide consultants with appropriate types of workstation and work areas at the appropriate times; to reduce space use and costs as much as possible, and to bring about business advantage through co-location.

The ubiquitous impact of mobile phones, laptops, the internet and email all seemed to presage an era in which work itself would be transformed: work could now be conducted in ways entirely different to even a decade previously. Working from home, hotels, trains and indeed just about anywhere was increasingly possible. Not only had the technologies released workers from the "place" issue, they had also brought the "anytime" option. Work, as many commentators noted, was quickly being defined as an activity rather than a place.

Design responded to the potential of emerging office technologies and the fashion in management texts with a new language in office design (Becker (1993); Duffy (1992); Harrison *et al* (2004) and National Audit Office (2006)). Enclosed offices, seen to reinforce hierarchies and individuals, as well as to consume space, were replaced by areas for group interaction, co-operation and innovation: *hot desking, hoteling, virtual offices, touchdown areas, lagoons, oases and docking stations* proliferated. And new types of workers were identified: *nomads, guests, teleworkers* and *core/periphery workers*, among countless others.

The workplace was also coming to be used as a lever of change within organisations; and one of the greatest proponents of this was the UK Government. Noting that many workers did not "*fully recognise the extent to which their physical workspace and its*

characteristics such as layout, appearance, comfort and functionality, affect their ability and motivation to work and the quality of the work they do", a key Government publication argued that "*the workplace can either support or hinder day-to-day operations, as well as help the process of change and improvement". It went on to state that "enlightened managers are responding by turning their workplaces into drivers for change*" in order to provide "*the right culture, management style, business processes and infrastructure to attract and retain the best people and support them in doing their work well*" (Allen *et al*, 2004).

It is in this context that the role of the workplace, and its design, in supporting organisational effectiveness, or productivity, is a critical one that has relatively recently come under the spotlight of senior management teams. Whereas in the past the workplace was seen by senior management simply as a leaden, inert and inflexible cost of doing business, it was now coming to be recognised as a strategic resource that could be actively managed to improve the productivity and wellbeing of the valuable and costly assets which it houses: the knowledge workers.

5.0 Productivity and wellbeing: a health warning ….

Despite the advances in workstyles, the increasingly densely occupied work environments failed to keep pace. There remained substantial concerns that the nature of open plan environments was affecting workers' ability to undertake their work *effectively* (Banbury & Berry (2005); Block & Stokes (1989); Hedge (1982); Leaman (1995)). The term 'sick building syndrome' was coined by the World Health Organisation in the mid-1980s to describe the link between the work environment and health and wellbeing.

Brunia *et al* (2016) observe that the debate about the pros and cons of open offices is still going on, citing Purdey & Leifer (2012) and Kim & De Dear (2013) as recent examples. But the debate continues. Chadburn *et al* (2017) argue that the results are not entirely conclusive. They suggest that while some research suggests a strong positive link between design and productivity (such as: Myerson *et al* (2010); Gensler (2005) and Sullivan *et al* (2013)), other work is less conclusive (such as Thompson & Kay (2008) and Greene & Myerson, 2011)).

Brunia *et al* (2016) extended the discussion from environmental factors affecting productivity to the nature of agile working. They argued that while most texts on the subject present a "*positive and optimistic picture*", by addressing "*the need for personal control over the environment" and the need to choose "a workplace that fits best with personal needs and work processes*", self-reporting surveys by employees tend to be more critical. Thus while "*many people can cope well with shared use of activity-based workplaces, quite a number of people complain about a lack of privacy, poor support of work requiring concentration and insufficient storage space*". The authors suggest Appel-Meulenbroek *et al* (2011); Brunia & Hartjes-Gosselink (2009); De Been & Beijer (2014); Maarleveld *et al* (2009); van der Voordt (2004), and van der Voordt *et al* (2012), for corroborating evidence.

The relatively recent tendency to see the workplace as a lever of organisational effectiveness has led to an almost frantic search by designers to demonstrate how this or that aspect of the workplace experience can influence productivity, or *effectiveness*. Environmental quality, facilities services, furniture, heating and lighting, and space planning are all routinely cited and measured. The question here is whether such

indicators are in fact sufficiently robust and reliable to form the basis of what can be quite radical and expensive workplace change programmes.

The real danger of extrapolating the impact of context-free influences is a form of reductionism: the tendency to divide the world into ever smaller boxes until, finally, we find one that helps to confirm our expectations. This process of description and categorising is comforting because it gives us a level of simplicity that isn't otherwise there. The danger comes when we use these specific boxes to generate prescriptive models that claim to provide a more general understanding. Such output can be used to help paint a picture that is incomplete and, at worst, possibly hopelessly wrong. It is therefore inadequate to argue that “we are working with the things within our control”.

In other words there is a danger that a set of narrowly focused variables is stretched almost to breaking point in an effort to explain issues or solve problems that actually require “cross cutting” thinking in order to provide workable and sustainable solutions.

Even within the narrower confines of office environment factors, the question of quantification (or translating lost productivity into a tangible number) has proved troublesome. Mawson (2002) drew attention to the fact that what “*no-one has managed to do yet is to describe in numerical or financial terms the lost productivity (individual or team) that results from failing to provide people with workplaces that support them in the tasks they conduct*”. He argued that while “*there can be little doubt that the physical environment has an impact upon the productivity of people in the workplace*” it is also “*abundantly apparent that it has proven exceptionally difficult to quantify the impact, largely due to the composite effect and the complexity around the relationship between the physical workplace and other influences on productivity such as morale, motivation and management*”.

While current approaches to measuring effectiveness are not wrong, *per se*, their limitations must be recognised. For example, empirical work usually limits the definition of *effectiveness* to that of the individual (rather than the organisation), and it tends to limit the definition of the *workplace* to the physical aspects of the fit out. Such approaches define the work environment as a physical entity, largely ignoring the business, social and systemic influences on performance.

In another example of the limitations, many empirical studies rely on self-reporting, whereby individual workers record whether they “feel” or “believe” that their effectiveness is affected by the environment, facilities, furniture, space planning and so on. Leaman & Bordass (2000) recognised the difficulty of defining a productivity measure for office occupiers, suggesting instead self-reporting on workplace factors as an acceptable surrogate. Indeed most practitioners and academics seem to take the view that in the absence of anything else, this approach will suffice.

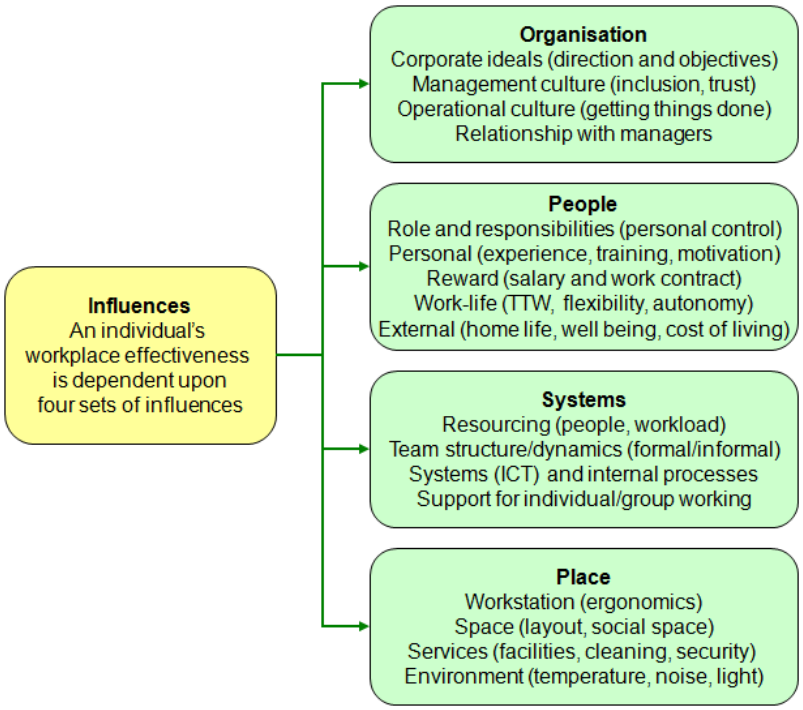
While the complexity of measuring the productivity of office workers has led some researchers to adopt occupier satisfaction with the office environment as a surrogate for productivity (Haynes, 2008a), this approach needs to be considered with care. Whilst there is evidence to suggest a correlation between 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.

Practical observations show that, no matter how well planned and responsive the work environment is, if individuals are not comfortable, or aligned, with the organisation, their effectiveness will suffer. Conversely, individuals who are highly aligned to an organisation, and deeply motivated by their work, might put up with all manner of workplace discomforts and shortcomings while at the same time being highly productive.

Again, while this is not wrong, such much data cannot possibly contextualise the motivations of the individual: how closely they are aligned with the organisation, their general level of work satisfaction, or their relationships with colleagues and bosses. In research studies of the workplace, influences and symptoms often get confused, and as a result, solutions can be unsustainable palliatives.

There are at least four areas which will influence an individual's productivity and wellbeing (Figure One). Some factors shown here are beyond the control of the workplace designer/manager; others can be more directly influenced. The key point here is that worker effectiveness is influenced to a very large degree by factors other than those generally investigated in workplace satisfaction surveys (Harris, 2008).

Figure One Influences on productivity and wellbeing



In order to design a workplace that is fully addressing productivity and wellbeing, Organisation, People, Systems and Place factors all need to be addressed in an integrated manner. This ecological approach recognises the interconnectedness of influences. Too many workstyle projects fail to have a demonstratively positive impact on the wider effectiveness of the organisation because they are based on a very narrow set of indicators.

An implication of Figure One is that, in order to improve productivity and wellbeing, workplace designers and managers will need to work less in isolation, and increasingly in multi-disciplinary teams. To be effective, the workplace will need to result from

collaborative efforts, "*where IT and HR along with workplace management are combined to achieve an effective integrated support service for business operations*" (McGregor, 2000). Workplace managers must engage with organisations in a far more meaningful fashion.

[They] *need to become 'multi-lingual' in terms of their ability to interpret the needs of their customers (individual, group and corporate) and translate facilities related issues into a language that enables them to communicate effectively with managers of the business.*

6.0 The empirical evidence

In the early-2000s, the attention of workplace designers and researchers was increasingly focused on understanding the range of factors that affect office productivity and worker wellbeing (Clements-Croome & Kaluarachchi, 2000) There are many that could be highlighted here, but the following selection (presented in chronological order) provides a good cross section.

Leaman & Bordass (2000) provided one of the earliest and perhaps most important categorisations of factors, or "*killer variables*" that affect productivity. The authors emphasise that each of the variables can be influenced through the design process and workplace management practice.

- **Personal control** Lack of environmental control is the single most important concern. This is supported by Bodin Danielsson & Bodin (2008); DEGW (2005) and Lee & Brand (2005).
- **Responsiveness** Relates to how quickly building managers respond to a complaint. This was reinforced by DEGW (2005), in terms of responsiveness of facilities management, and the simplicity/manageability and the efficient operation of the building and its systems
- **Building depth** Deeper, air-conditioned buildings have a more negative effect on perceived productivity than shallower, naturally ventilated buildings.
- **Work groups** Refers to the dis-benefits that accrue with larger groups, and that "*perceptions of productivity are higher in smaller more integrated workgroups".*

In an update to this work, Leaman & Bordass (2005) added a fifth "killer variable"

- **Design intent** Refers to the potential mismatch between the design intent of an office and its actual use.

In other words, and taking all five variables, productivity is enhanced when there is greater personal control over the environment; when issues get resolved quickly; where the configuration of space is shallower and naturally ventilated; where work groups are appropriately sized, and where there is a direct understanding of what the space is designed to achieve.

Thompson & Kay (2008) undertook an extensive review of studies and concluded that there would be an increased likelihood of the workplace impacting positively on workplace productivity if the following features were present.

- Controllability of immediate environment.
- Maximum daylight.

- Few visual distractions (when distraction-free working is required).
- Lighting appropriate to the task.
- A blend of work settings that reflect business needs.
- Flexibility of design and infrastructure to accommodate change.
- Good internal air quality.
- Spaces for social interaction, relaxation and 'psychological restoration'.
- Opportunities for learning and information sharing.
- Creation of a sense of place and social equity.
- Managed by a customer-focused facilities management function.

This range of factors is typical, with one notable exception: there is no mention of open plan environments and noise distraction (which we return to below).

Similarly, Myerson *et al* (2010) undertook survey work to gather evidence on the impact of the physical environment. They showed that staff felt encouraged to perform better in an environment which allowed for changes in lighting, acoustics, furniture, technology and ambience.

Oseland and Burton (2012) reviewed 75 studies that measured the productivity impact of specific workplace variables. The reviewed studies had different methodologies (e.g. studies conducted within an office environment and those conducted in simulated environments), so their findings were weighted to account for variables.

After weighting the studies, the research concluded that the average productivity impact of improving specific environmental conditions, when taken independently, ranged between 1.1% and 3.5% (see Table). The aggregate effect of improving a combination of factors within a workplace was less clear. Review and weighting of 22 'general' studies that considered a range of workplace improvements concluded that they showed improvements in the range of 1.2% to 3.2% with a mean impact of 2.7%.

Factor	No studies reviewed	Average weighted impact on productivity
Lighting	17	1.1%
Noise	10	1.4%
Temperature	16	1.2%
Ventilation	16	1.4%
Control	10	1.2%
Furniture	8	2.1%
Space	3	3.5%

While not definitive (and it is important to note that the study does not include several important factors that form part of a productive workplace, such as design, range of available work settings and effective space management), this study gives an indication of the range in potential productivity gains that might be expected following improvement to the workplace. This suggests that a noticeable benefit is likely, but that it is not in the order of ten per cent.

The World Green Building Council (2014) developed a simple framework to help companies act to create healthier offices. The framework assesses key environmental factors which affect health and wellbeing, surveys employees to find out how they experience them, and measures economic factors they influence, such as productivity,

absenteeism and medical costs. The report identified eight key factors in creating healthier and greener offices which can impact on the bottom line. Its review of evidence highlighted the following.

- **Indoor air quality and ventilation** A well-ventilated office can result in an 8-11% productivity increase and double cognitive ability.
- **Thermal comfort** Staff performance can fall by 6% if offices are too hot; and by 4% if too cold.
- **Daylighting and lighting** A study found workers in offices with windows got 46 minutes more sleep a night than workers without them and The World Green Building Council reports the benefits of being close to daylight: the productivity of focused work increased by 15% for workers close to a window.
- **Noise and acoustics** Noise distractions can lead to a 66% drop in performance and concentration.
- **Interior layout and active design** Flexible [agile] working helps staff feel more in control of workload and encourages loyalty.
- **Biophilia and views** Processing time at one call centre improved by 7-12% when staff had a view of nature and another study demonstrated that adding houseplants to an otherwise sparse office environment increased perceived wellbeing by 47%, creativity by 45% and productivity by 38%.

Morgan Lovell (2014) investigated the working conditions, attitudes and expectations of 2000 UK office workers, to "*reveal the transformations to culture and design that are needed to drive greater performance*". The survey showed that almost three-quarters (74%) of respondents "*believe that their work environment supports their physical wellbeing*". While encouraging, the authors note that this means that "*more than one in four UK office workers languishing in unhealthy environments*".

The survey also found that over a quarter (26%) of employees find the acoustics of their office unpleasant, and three-quarters (77%) of those blamed this on a noisy open-plan environment. A further quarter (27%) are frustrated by a lack of privacy. Of the quarter (23%) who state that their office does not encourage them to move around, three-quarters (72%) blame the awkward design of their workplace. Chief gripes regarding office design are a lack of colour (80%), a lack of greenery (64%) and a lack of art (61%).

Brunia *et al* (2016) suggest that there are some underlying issues that are atemporal and aspatial. For example, they cite the work of Brill and Weideman (2001), which comprised the responses of 13,000 office workers in different settings. The survey found that the factors most critical for a successful and productive work environment included:

- the ability to work alone without being distracted;
- conditions for spontaneous interaction, meetings and distraction-free group work;
- workplace comfort and ergonomics;
- enough space for items;
- high-quality lighting and daylight; and
- personal control over temperature and air quality.

Mulville et al (2016) This research aimed to understand how a range of ambient environmental conditions and occupant behaviour may impact upon perceptions of comfort, health, wellbeing and ultimately productivity in the workplace.

The research demonstrates that significant differences can exist in relation to comfort, health, wellbeing and by extension productivity within individual buildings, and that this may not always be reflected in measurable differences in directly related ambient conditions. This suggests that, within the generally accepted comfort ranges, there may be a hierarchy of the influence of environmental factors, with noise levels of particular importance. Gender factors and access to controls present further challenges in providing productive workspaces in open-plan configurations, where desk level control (of local conditions) may be of benefit. Furthermore, occupant workplace behaviour was found to be a significant factor in perceived environmental comfort and wellbeing. It may be that changes in occupant behaviour, in this case frequency of breaks, can improve satisfaction and wellbeing.

Chadburn *et al* (2017) undertook a survey of 213 employees in eight financial and professional services firms in Central London. Their findings showed that comfort, convenience, IT connectivity, good design and working to a specific time scale were strong drivers of personal productivity. Knowledge workers prefer a flexible range of office settings that enable both a stimulating open and connected work environment, knowledge sharing, collaboration, as well as, quiet concentration locations, free of distractions and noise.

While the studies referred to above have taken a systemic approach to workplace features affecting productivity, others have taken a more detailed look at specific elements. Here we summarise some of these.

Lighting An argument has also been made by Veitch (2005), who proposes that people have a preference to natural lighting over artificial lighting, and that there is a link between natural lighting and improved productivity. People who had access to a window were more satisfied with their lighting than those that have no access to a window. It was seen that employees that were situated near windows tended to be more focused and relaxed.

Temperature Office temperature is another important physical aspect of office design. Clements-Croome and Baizhan's (2000) analysis showed that "*the most common complaints about unsatisfactory environments*" were connected with high or low temperature variations, stale and stuffy air, or, dry or humid air. It was noticed that when dissatisfaction was high, self-assessed and productivity was reduced. It was also noted that if the temperature was too hot or cold workers become distracted and productivity was reduced.

Air quality Mulville *et al* (2016) note that indoor air quality has been shown to have a significant impact on occupant health, wellbeing and productivity, and they cite Dorgan and Dorgan (2005); the World Green Building Council (2014) and Bodin Danielsson *et al* (2014).

Clements-Croome (2015) notes the importance of ventilation, comparing it to the human need for water and highlights the interrelationship between ventilation rate, temperature and humidity noting that increasing levels of ventilation are required to maintain feelings of "freshness" as temperatures increase.

Distractions and privacy With respect to the social environment it can be seen that less research work has been carried out. However, Haynes (2008b) shows that interaction was perceived as having the most positive effect on productivity, whilst distraction was the most negative, and the findings in this research were consistent across various types of workers. In agreement is Mawson (2002) who argues that the cumulative effect of distractions over a day leads to a disruptive and less productive day when knowledge workers are focused on an individual task.

Blackwell (2016) reported on a survey of 2,800 'knowledge workers', which revealed that just over two thirds (69%) of respondents "stated that their workplace design directly affected their effectiveness". More specifically, 51% reported that reducing extraneous office noise was the most important factor for improving their productivity; and 35% stated that that access to quiet space was the third most important design factor for their productivity – unsurprising given the result on extraneous noise.

Brunia *et al* (2009) argue that large open workspaces, accommodating more than approximately 15 people, should be avoided due to concentration and privacy issues and that large open spaces should be visually and acoustically subdivided in smaller areas. These findings are borne out by Hedge (1982).

Layout and configuration Privacy is another social aspect that has been looked into and Nathan and Doyle (2002) found that open plan and shared offices have most complaints about lack of privacy. In addition, it was highlighted that badly designed workplaces affect staff negatively, both physically and in their overall well-being. This is supported by a study by van der Voordt (2004) who shows that open-plan offices can cause increased crowding and loss of privacy. Herein, it is recommended that a combi-office approach is preferable in order to cope with different work processes. His findings are supported by Peterson and Beard (2004), and Haynes (2008a and 2008b) who also acknowledge that the physical environment should create different kinds of work settings to allow collaborative and private work. It is also noteworthy that Bodin Danielsson (2008) analysed office types in relation to worker's health, well-being and job satisfaction. In this research, it was found that one of the lowest job satisfaction measurements were within open plan offices.

Green buildings Miller et al (2009) argue that 'green' buildings improve productivity and reduce absenteeism. Their survey of over 500 environmentally-certified buildings found their workers to be more productive, reduce absenteeism and improve attraction and retention of staff. More evidence supporting this argument shows that sustainable buildings decrease business costs and energy costs and increase the value of the built asset, as the increasing societal awareness of green buildings deepens the demand for sustainable buildings (Newell, 2009; Thompson, 2008).

A recent report from the British Council for Offices has proposed that the definition of a productive workplace should include four inter-related elements: health, efficiency, effectiveness and engagement. The research states that, in combination, "*these factors can remove many obstacles to productivity; they can enhance productivity, and they can introduce productivity. They also work at the level of the organisation, the team, and the individual worker*". The scope of each of the above dimensions is described further in the Table below.

Healthy – supporting and improving individual wellbeing at work
A safe and secure environment
Active design features that encourage movement
Ergonomic furniture supporting a range of work styles
Comfortable light levels with access to natural light
Connection with nature through natural materials, views, green spaces and art work
Optimum indoor air quality and temperature range
A clean and tidy environment
Access to good nutrition and hydration
Efficient – making good use of space, time and information
Efficient access, entry, exit and navigation
Minimal time spent looking for spaces, people, information or services
Optimum use of available space through ongoing review of performance and utilisation
High levels of service with responsive and effective day to day and strategic management
Effective – enabling people to do their work well
A variety of spaces match the workstyles of the building's users
Sufficient quality space for concentration and contemplation
Spaces for planned and incidental communication and collaboration
Shared amenity areas and events support ad hoc working, recharging and collaborating
Technology and other resources enable flexible access to, and sharing of, information
Appropriate choice in selection of the right place and conditions in which to work
Acoustic and visual control enables effective use of each workspace
Engaging – a desirable destination that looks and feels like a great place to work
A high-quality people centric experience through design, space, technology and services
Supports a sense of belonging and community
Reflects the corporate brand, culture and values
Supports life at work with amenities, services and conveniences

7.0 Conclusions

This paper has demonstrated how 'the workplace agenda' has evolved over recent years, and how this has led to the current focus on productivity and wellbeing. There is now a widespread acceptance in the design, development, occupation and management communities that the output, or effectiveness, of office workers is directly related to their sense of physiological and psychological wellbeing. The research demonstrates a clear link between the work environment and wellbeing; and there is an emerging focus on designing and managing places that energise, encourage social interaction and collaboration, enhance personal control and provide services and events to manage and improve people's quality of work experience.

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