Environmental Demands and Resources: A Framework for Understanding the Physical Environment for Work

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Abstract

Purpose: To explore the extent to which Job Demands-Resources (JD-R) theory (Demerouti *et al.*, 2001; Bakker and Demerouti, 2017) is an appropriate conceptual framework for understanding the physical environment for work.

Design/Methodology/Approach: A conceptual analysis of the multidisciplinary workplace literature was performed to assess the core propositions of JD-R theory as they relate to the workplace environment.

Findings: The analysis confirms that the workplace environment can be viewed as a composite of environmental demands (which instigate a health impairment process) and environmental resources (which trigger an engagement process). Employees proactively try to improve the suitability of their workspace through environmental crafting, motivated by minimising demands and maximising resources.

Originality: The application of JD-R theory to the workplace environment fills a gap in the literature for a framework which captures the dynamic nature of the employee-workplace relationship.

Modern corporate real estate practice operates predominantly under a cost reduction paradigm, in which *efficiency* (i.e. optimising the use of the space) is generally prioritised over *effectiveness* (optimising the extent to which employees are able to carry out their work) (Harris, 2019; Haynes, 2007). This is exemplified by recent workplace trends such as the transitions from private to open-plan offices and from assigned seating arrangements to flexible working practices, which are both motivated at least in part by the desire to achieve greater space efficiency

However, there are increasing concerns that this trade-off has led to unhealthier working environments. Modern open-plan offices are associated with lower environmental satisfaction, poorer health, and lower productivity amongst their users (Bodin Danielsson and Bodin, 2008, 2009; Bodin Danielsson *et al.,* 2014; Kim and de Dear, 2013). Moreover, the purported benefits of these offices (e.g. improved interpersonal communication and collaboration, greater autonomy over working location) have typically not been supported (Bernstein and Turban, 2018; Engelen *et al.,* 2018; Kaarlela-Tuomaala *et al.,* 2009; Kim and de Dear, 2013; Pejtersen *et al.,* 2006).

As such, it has been argued that the cost reduction paradigm should be supplanted by a new approach which recognises that employees are crucial assets whose value can be amplified through the provision of more supportive working environments (Haynes, 2007). To achieve this, workplace research and practice should be guided by a clear conceptual framework which represents the relationship between the employee and the myriad environmental factors which detract from or support healthy and productive work. However, the extant workplace environment literature is segmented by specialism and largely atheoretical (e.g. Ashkanasy *et al.,* 2014; Sander *et al.*, 2018). The limited use of theory, when translated into practice, raises the risk of iatrogenesis (i.e. well-intentioned

interventions which inadvertently do more harm than good), due to insufficient understanding of the complexity of the entire employee-workplace ecosystem.

To address the need for a suitable conceptual approach, in this paper we present a new theoretical framework for the workplace environment, termed the Environmental Demands-Resources (ED-R) model. This novel framework can be considered to be a domain-specific extension of one of the most popular and influential models of work stress from the organisational literature, the Job Demands-Resources (JD-R) theory (Demerouti *et al.,* 2001; Bakker and Demerouti, 2017), as well as serving as a standalone framework to represent the complex employee-workplace relationship.

The core proposition of JD-R theory is that all jobs share common factors associated with human wellbeing and functioning. These characteristics can be conceptualised as *job demands* ("aspects of the job that require sustained physical or mental effort and are therefore associated with certain physiological and psychological costs"; Demerouti *et al.,* 2001, p. 501) or *job resources* ("aspects of the job that may do any of the following: (a) be functional in achieving work goals; (b) reduce job demands and the associated physiological and psychological costs; (c) stimulate personal growth and development"; Demerouti *et al.,* 2001, p. 501). It has been noted that the distinction between demands and resources can often be ambiguous (e.g., a lack of resources might be construed as a demand), and so a general rule has been proposed that demands are those characteristics which are always appraised negatively, whereas resources are appraised positively (Schaufeli and Taris, 2014).

Job demands and resources influence work outcomes through two mediating pathways. First, chronic job demands and a scarcity of job resources instigates the process of exhaustion. The presence of demands requires the employee to expend higher levels of energy to achieve work-related goals, with insufficient time for recovery. Concurrently, the

absence of job resources leads to a state of disengagement in which the employee loses the motivation to continue expending effort to overcome the demanding circumstances. The combination of exhaustion and disengagement is symptomatic of burnout, and is also associated with other physical and mental health impairments (Demerouti *et al.,* 2001; Bakker and Demerouti, 2017).

Conversely, the presence of job resources triggers the separate pathway of work engagement. Job resources are intrinsically motivating because they satisfy fundamental human needs. This leads to a state of engagement characterised by vigour, dedication, and absorption, which is in turn associated with positive outcomes such as positive affect, extra-role performance, and higher productivity (Demerouti *et al.,* 2001; Bakker and Demerouti, 2017).

Whilst certain demands and resources might be intrinsic to the job itself, employees may also be able to use *job crafting* strategies to maximise resources and minimise demands. Job crafting refers to the proactive steps taken by employees to alter the nature of their work (*task crafting*), the relationships they have with colleagues and clients (*relationship crafting*), and/or the way in which they appraise their work (*cognitive crafting*) (Wrzesniewski and Dutton, 2001). Essentially, the purpose of job crafting is to reduce demands and to increase resources (Tims *et al.,* 2012).

Despite the fact that an unfavourable work environment was highlighted as a potential job demand in the original conceptualisation of the JD-R model (Demerouti *et al.,* 2001), very few studies have explicitly considered environmental factors as potential job demands or resources (for exceptions, see Hakanen *et al.,* 2005; Morrison and Macky, 2017). Instead, job demands and resources have typically been conceptualised as personal, social or

organisational factors. Similarly, there has been limited consideration of the crafting strategies employees might use with respect to the workplace environment.

Therefore, the purpose of this paper was to address these gaps by performing a conceptual analysis of the workplace environment literature, considering the extent to which the propositions of JD-R theory are logically supported in the novel domain of the workplace environment. Specifically, the conceptual analysis was guided by the following three research questions: "Which aspects of the workplace environment can be conceptualised as job demands?"; "Which aspects of the workplace environment can be conceptualised as job resources?"; "Which environmental behaviours at work can be conceptualised as examples of job crafting?"

Methodology

To perform the conceptual analysis, we followed a slightly adapted version of the phases Jabareen (2009) proposed for the development of conceptual frameworks. JD-R theory had already provided us with *a priori* assumptions about the nature of the concepts and their interrelationships, as described in the previous section. Therefore, rather than 'discovering' the concepts by reviewing the literature, we aimed instead to evaluate their logical consistency. As such, the three-phase approach to the conceptual analysis was as follows: (1) Map the disciplines and topics comprising the multidisciplinary workplace environment literature; (2) Extensively read and categorise the literature; (3) Evaluate the logical consistency of the proposed concepts.

To map the relevant workplace environment disciplines, we used the model proposed in the recent review by Forooraghi *et al.* (2020), which largely corresponds with the factors

discussed in previous reviews of the multidisciplinary workplace literature (e.g. Al Horr *et al.,* 2016a, 2016b). Accordingly, the workplace environment is conceptualised as a series of factors arranged into three higher-order categories: (1) indoor environmental quality (IEQ; the physical conditions inside the building, e.g., indoor air quality, thermal environment, luminous environment, acoustic environment); (2) spatial factors (the arrangements and nature of the office furnishings, e.g. interior design and spatial layout); and (3) socio-spatial factors (the interaction between the office space and its users, e.g., perceived privacy, perceived territoriality, perceived autonomy).

For the second phase, the aim was to understand how each environmental factor related to occupants' health, wellbeing, and/or productivity within offices. To identify the relevant literature, we used keyword searches within Scopus (search terms shown in Table 1) in order to identify studies relating to employee health, wellbeing and/or productivity within each workplace environment discipline. To identify further suitable papers which may have been missed by the initial searches, we also scanned the reference lists and citing articles of the papers which had been identified. The primary author scanned the titles and abstracts of the articles within the search results before reading the full text of relevant articles. This resulted in a database of 433 research articles which the primary author read in full.

Finally, the third phase was addressed by identifying, categorising, and integrating common concepts across the disciplines. Specifically, we assessed the extent to which our *a priori* assumptions about the applicability of JD-R theory to the workplace environment were valid. This was done by assessing the extent to which the content of the papers aligned to the conceptual framework of demands, resources, and crafting behaviours. For the purposes of this paper, the articles listed in the Results section are those which were subjectively judged to best exemplify these concepts for each workplace environment discipline. Due to the very broad scope, we prioritised systematic review papers published in the last decade where

possible, although these were not available for all disciplines, and so field studies and laboratory studies were also included where the findings were generalisable to real office environments.

Overall, the conceptual analysis process yielded an initial typology of 'environmental demands', 'environmental resources', and 'environmental crafting' strategies (Table 1).

INSERT TABLE 1 HERE

Results

Which aspects of the workplace environment can be conceptualised as job demands?

The defining characteristic of a job demand is that its presence requires that the employee expends additional energy to achieve the same goal (Demerouti *et al.,* 2001). There is a similarity here with Vischer's (2007) concept of 'workspace stress', defined as the degree to which users have to compensate for adverse environmental conditions and expend additional energy to achieve work-related goals. Essentially, this can be caused by physical discomfort (health impairments, ranging from mild disturbance to more serious problems) and/or functional discomfort (interference with the successful completion of work-related activities) (Vischer, 2008).

Clear contributors towards physical and functional discomfort were identified across each of the three higher-order workplace categories. In terms of IEQ, several review papers highlight common airborne pollutants within offices which are associated with the development of "sick building syndrome" symptoms (e.g. headaches, tiredness, respiratory

irritation), such as particulate matter (Nezis *et al.,* 2019) and volatile organic compounds (Tsai, 2018). If humidity is low, these symptoms are exacerbated (Wolkoff, 2018). In this way, polluted indoor air results in a mental state which makes the completion of work-related activities more difficult, contributing to psychological stress as well as impairments to physical health.

Characteristics of the luminous and thermal environment can also cause discomfort. Visual discomfort and eyestrain can be caused by lighting configurations providing insufficient light and/or producing the sensation of glare (Carlucci *et al.,* 2015). Additionally, limited access to daylight causes diminished alertness and cognitive response (Aries *et al.,* 2013), because the regulation of circadian rhythms (which govern the sleep-wake cycle) depends upon the stimulation of a certain type of photoreceptor which is maximally sensitive to a wavelength contained within natural daylight but not typically in artificial light (Lucas *et al.,* 2014). In terms of the thermal environment, temperature complaints are common within offices, and are also associated with lower productivity (Rupp *et al.,* 2015).

With respect to purely spatial factors, the greatest potential contributor towards physical discomfort is the ergonomic design quality. For example, the development of musculoskeletal symptoms in the spine and neck has been associated with non-adjustable seating arrangements, poor posture, and a close keyboard position to the body (Jun *et al.,* 2017). Another issue is the requirement for prolonged sitting at work. High sedentary behaviour contributes to musculoskeletal pain, as well as the development of even more serious health impairments such as type 2 diabetes, cardiovascular diseases, and certain types of cancer (Owen *et al.,* 2008).

Finally, in terms of socio-spatial factors, the literature highlights a worsening of various forms of discomfort in open-plan offices. In particular, distraction by speech is a very common complaint within open-plan offices (Bodin Danielsson and Bodin, 2009). For this reason, occupants of open-plan offices report approximately tenfold more acoustic complaints (Pejtersen *et al.,* 2006) and a doubling in the amount of time wasted due to noise (Kaarlela-Tuomaala *et al.,* 2009) compared with those in enclosed offices. Open-plan offices are also associated with lower perceived acoustic and visual privacy (Bodin Danielsson and Bodin, 2009; Kim and de Dear, 2013) and higher perceptions of crowding (Sundstrom *et al.,* 1980). In turn, this contributes to higher levels of emotional exhaustion (Laurence *et al.,* 2013).

In sum, there is evidence to conclude that numerous disparate aspects of the workplace environment are unified by the fact that they cause physical or functional discomfort. Borrowing terminology from the JD-R model, we refer to these as *environmental demands*. These demands directly or indirectly impair physical or mental health, triggering a pathway labelled 'strain'. In the face of demands, employees must exert increased physical and/or psychological effort in order to achieve the same outcomes. Hence, chronic exposure to environmental demands increases the likelihood of physical and mental health deficits, burnout, and low productivity.

Proposition 1: The physical workplace environment contains "environmental demands. which instigate a health-impairment process and have a negative impact on job performance.

Which aspects of the workplace environment can be conceptualised as job resources?

Job resources stimulate work engagement by supporting fundamental psychological needs, thereby buffering the impact of job demands on strain (Demerouti *et al.,* 2001). This is similar to Vischer's (2008) concept of psychological comfort, which relates to aspects of the environment which engender perceptions of belonging, territoriality, and ownership in the workplace. The concept can be further extended to other psychological needs, such as the 'sense of coherence' (i.e. the extent to which one's environment is perceived as comprehensible, manageable, and meaningful) which underpins the salutogenic theory of health promotion (Antonovsky, 1996).

The clearest examples of environmental resources come from features of interior design. In particular, the integration of nature and natural analogues into the indoor built environment ('biophilic design') makes the workplace more manageable by enabling employees to cope more effectively with stress. Exposure to nature instigates a 'restorative' process characterised by reduced stress and the recovery of depleted attentional resources (Hartig *et al.,* 2014), and also has 'instorative' benefits which arise even when cognitive resources are not depleted (Beute and de Kort, 2014). As such, when nature is integrated into the workplace environment, employees experience benefits including reduced stress, higher productivity, and improved overall wellbeing (Gillis and Gatersleben, 2015).

Personally-meaningful artefacts also serve as environmental resources, as high job meaningfulness is associated with higher job satisfaction and motivation, and lower absenteeism and turnover intentions (Dik *et al.,* 2013). Indeed, personalisation serves to foster positive emotions, accelerate personal identity expression, and imbue the workplace with a sense of meaning (Ashkanasy *et al.,* 2014; Brunia and Hartjes-Gosselink, 2009; Wells,

2000). In offices with low privacy, employees who personalise their desk are at lower risk of experiencing emotional exhaustion than those who do not (Laurence *et al.,* 2013).

The 'look and feel' of the workplace may have a similar effect, through the mediating pathway of positive affect. Indeed, philosophers of architecture recognise that the aesthetic appreciation of architectural objects gives rise to an extended range of psychological states (Fisher, 2016). Although studies quantifying the correlates of aesthetic appreciation in the workplace are rare, there is evidence to suggest that creativity tends to be higher in aesthetically-interesting spaces (McCoy and Evans, 2002) and that judgments of aesthetic quality contribute to overall workplace environment satisfaction (Bodin Danielsson, 2015). Hence, artefacts or design features judged to be 'beautiful' may also function as environmental resources.

Beneficial psychological states can also be elicited by certain aspects of IEQ. For example, exposure to pleasant fragrances tends to induce positive affect, which in turn leads to more optimistic goal-setting, more cooperative conflict resolution, and higher task performance (Baron and Bronfen, 1994; Baron and Thomley, 1994). Positive affect might also be elicited through acoustic soundscapes playing sounds from natural environments (e.g. birdsong, rippling water) (Benfield *et al.,* 2014), thermal environments which elicit pleasurable sensations ('thermal alliesthesia') rather than neutrality (Parkinson and de Dear, 2014), and lighting configurations which are sufficiently non-uniform to be characterised as interesting (Veitch, 2001). However, supporting evidence for these additional strategies remains relatively scant at present.

Finally, socio-spatial characteristics can also indirectly support traditional job resources (e.g. co-worker and supervisor support) by facilitating interpersonal communication. However, improvements in interpersonal relations are not typically

observed following a transition to open-plan spaces (Bernstein and Turban, 2018; Kaarlela-Tuomaala *et al.,* 2009; Kim and de Dear, 2013; Morrison and Macky, 2017; Pejtersen *et al.,* 2006), so the challenge remains for workplace practitioners to develop effective strategies for increasing the likelihood of interpersonal contact and interaction but at no expense to individual privacy.

In sum, although the evidence base requires further development, there is good evidence that at least some aspects of the workplace environment independently support work engagement by supporting fundamental psychological needs. We conceptualise these elements as *environmental resources.* The absence of environmental resources does not directly cause strain, but rather their presence triggers a separate motivational pathway which improves motivation and buffers the impacts of demands (environmental or otherwise) on strain. In this way, environmental resources support physical and mental health, helping employees to work more productively.

Proposition 2: The physical workplace environment contains "environmental resources" which instigate a motivational process, buffer the impact of demands on strain, and have a positive impact on job performance.

How can we understand employees' environmental behaviours at work?

Job crafting refers to proactive changes employees make to increase their job resources and decrease their job demands (Tims *et al.,* 2012). Many workplace behaviours can be understood in this manner, as a particular type of coping behaviour in which the employee actively improves the suitability of the external environment to make it more

aligned to their preferences and requirements (i.e. by reducing environmental demands and/or increasing environmental resources). When the autonomy to do so is restricted, the "learned helplessness" response can occur, in which the individual simply succumbs to the inappropriate conditions instead of trying to improve them, resulting in depressive symptom and poorer work performance (Evans and Stecker, 2004). Hence, it is crucial to consider the different crafting strategies an employee might effectively use within the workplace.

Wessels *et al.* (2019) distinguish two types of job crafting relating to the workplace environment. *Spatial crafting* refers to decisions over where to complete work, including different types of workspace within the office and which could also extend to spaces outside of the office (e.g. home office, café). *Time crafting* refers to decisions over when to complete work, recognising that the same environment might be more or less suitable (due to the presence or absence of colleagues) at certain times of the day. Enhancing time-spatial job crafting is one of the major justifications for non-territorial working policies such as 'activity-based working', in which employees are expected to regularly use different workspaces for different activities (Veldhoen, 2008).

In practice, however, the evidence base for activity-based working is equivocal (Engelen *et al.,* 2018), and a significant proportion of employees retain a territorial working style (e.g. Skogland, 2017). Here, it can be recognised that a conflict exists between what Elsbach and Pratt (2007) refer to as the instrumental and symbolic functions of the workplace. If the employees already perceive low demands at their primary workspace, then attempts to encourage them to switch workstations conflict with their wish to maintain familiar and psychologically comfortable workspaces. Hence, supporting time-spatial job crafting may not always have the anticipated benefits.

In addition to spatial and time crafting, the literature also reveals the existence of crafting strategies motivated by improving conditions in the immediate local environment, by improving design and/or by reducing discomfort. For example, just as the artefacts of personalisation can be conceptualised as environmental resources, so too can the process of personalisation be understood as an example of crafting. Acoustic disturbances can be reduced through the use of personal headphones (Oseland and Hodsman, 2018) and thermal discomfort can be mitigated through the use of personal fans or heaters (Liu *et al.,* 2013) or even desk chairs with built-in heating and cooling mechanisms (Kim *et al.,* 2018).

In summary, various workplace behaviours are directly motivated by the desire to create a more suitable working environment (by mitigating environmental demands and/or enhancing environmental resources). Examples might include moving to a new working location, changing the time at which one works, and/or altering the local environmental conditions at the workspace. Collectively, these can be referred to as *environmental crafting.*

Proposition 3: To the extent that they are able to do so, employees will use crafting behaviours to minimise demands and maximise resources in the workplace environment.

Discussion

In this paper, we performed a conceptual analysis of the multidisciplinary workplace literature, using indicative studies to demonstrate that the core concepts of JD-R theory (Demerouti *et al.,* 2001; Bakker and Demerouti, 2017) are also applicable to the workplace environment. Therefore, a domain-specific version of the theory presented separately as the

ED-R model (Figure 1) is judged to be a suitable conceptual framework to represent the complex and dynamic nature of the employee-workplace relationship.

INSERT FIGURE 1 HERE

Specifically, the analysis showed that the workplace environment is as a composite of environmental demands, which instigate a health impairment process (through physical and/or functional discomfort) and negatively impact job performance, and environmental resources, which trigger a motivational process (through psychological comfort) and positively impact job performance. Whilst certain environmental demands and resources are outside the control of the employees, employees can improve the workplace through environmental crafting behaviours (i.e. minimising demands and/or maximising resources).

The presence of demands and resources (relative to the idiosyncratic needs of each employee) determines the overall level of *employee-workplace alignment.* This is a similar concept to "functional and psychosocial congruence" (Heerwagen *et al.,* 1995). need-supply fit" (Gerdenitsch *et al.,* 2018; Wohlers *et al.,* 2019), "work pattern-office type (mis)fit" (Soriano *et al.,* 2018), and one component of "person-environment fit" (a broader concept which also includes congruence with the broader psychosocial and organisational environment; Edwards and Billsberry, 2010). In line with the ED-R model, previous studies have confirmed a significant positive association between perceptions of alignment and productivity (Gerdenitsch *et al.,* 2017; Soriano *et al*., 2018; Wohlers *et al.,* 2019).

Practical Implications

From a practical perspective, a major implication of ED-R theory is recognising the myriad environmental forces acting upon individuals in the workplace environment. Consequently, practitioners should perform more comprehensive evaluations of demands, resources, and crafting opportunities within the workplace environment, to get a truer understanding of workplace effectiveness. The tentative typology presented in Table 1 provides a starting point for understanding the different factors which should be assessed.

The assessment of environmental demands and resources can also improve workplace intervention delivery. Broadly, the ED-R model suggests that the provision of more effective workplaces relies on a combination of three broad strategies. Two of these are practitioner-led, top-down strategies: the mitigation of environmental demands (e.g. creating silent working areas) and the enhancement of environmental resources (e.g. placing interior plants within the office). The third strategy is to facilitate the user-directed, bottom-up process of environmental crafting (e.g. implementing flexible working policies).

Finally, both prior to and after the intervention has occurred, a comprehensive evaluation of environmental demands, environmental resources, and perceptions of overall employee-workplace alignment should occur. This will minimise the risk of iatrogenesis, and help to ensure that the intervention really did have the intended effect.

Limitations and Suggestions for Future Research

The strengths and limitations of the ED-R model are largely shared with the JD-R model (e.g. Schaufeli and Taris, 2014). The main strength of the model is its flexibility. Any aspect of the environment can be included in the model as a demand or resource, any subjective or objective measure of wellbeing or productivity can be included as a component

of overall job performance, and a range of organisational behaviours can be interpreted as examples of environmental crafting. In this way, the model encourages researchers and practitioners to adopt a holistic view of the entire workplace environment and the employees' responses within it.

However, this generalisability comes at the cost of limited specificity, so additional frameworks will be needed to explain the numerous individual relationships contained within the model in more detail and with greater predictive power. Indeed, more research is needed in general to validate the propositions of the ED-R model. At present, no predictions are made about the strength of the relationship between each demand or resource and overall job performance. Possibly, trying to quantify these relationships might be further complicated by the fact that there is still limited insight into the combined effects of different aspects of the environment, as the vast majority of prior research has attempted to isolate the effects of just one or two components at a time. As such, it remains unclear whether multiple demands and/or resources will be additive or multiplicative in their effects.

It will be important to develop research into exactly which demands are most detrimental and which resources are most conducive to job performance. The limited extant literature highlights the importance of supporting productivity by ensuring that distractions in the workplace environment are minimised (e.g. Roskams and Haynes, 2019a). However, it is possible that different types of employee will require different types of intervention, so more field-based research is needed at a greater variety of workplaces to better inform the evidence-based approach to practice.

There is also an asymmetry in the strength of evidence for different aspects of the model. The existence of environmental demands is clearly supported by numerous systematic reviews, but the evidence in support of certain environmental resources (with the

exception of biophilic design) is more tentative and based on individual studies. This will also be important to address in future research. A truly 'healthy' workplace entails not only the mitigation of harm-causing 'pathogenic' factors but also the enhancement of health-promoting 'salutogenic' factors (Heerwagen et al., 1995; Roskams and Haynes, 2019b). It would be valuable in future research to investigate exactly which environmental resources are most useful for buffering the impact of job demands on strain, and which are most useful for promoting work engagement.

Finally, it should be recognised that organisations will continue to be motivated by cost-reduction concerns, and so the provision of workplaces which are entirely free of demands and resource-abundant may not be possible. Hence, the most pressing concern for researchers and practitioners is to explore the most effective ways to resolve the inherent tensions of shared modern offices. How can requirements for privacy and quiet work be best supported within open-plan spaces? If personal identity expression needs to be restricted in non-territorial offices, can psychological comfort be maintained in other ways? Do personal comfort systems enable users to improve their individual comfort without the risk of adversely affecting co-workers? The answers to these types of question will be crucial for helping practitioners to understand how to provide more effective workplaces, whilst still meeting organisational requirements for efficiency.

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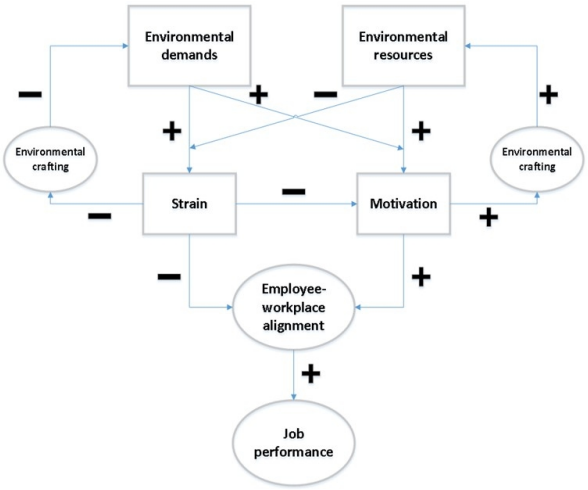

Figure 1: The Environmental Demands-Resources model

338x190mm (96 x 96 DPI)

Table 1. The results of the conceptual analysis of the multidisciplinary workplace environment literature. The three right-hand columns present an initial typology of environmental demands, environmental resources, and examples of environmental crafting.

Workplace Environment Factor	Keyword Search[1]	Environmental Demands	Environmental Resources	Environmental Crafting
Indoor Air Quality	"indoor air quality" OR "indoor air pollutants" OR "ventilation rate" OR "air quality"	CO_2; CO; O_3; VOCs; $PM_{2.5}$; PM_{10}; NO_2; Humidity; Unpleasant odours	Pleasant fragrances	
Thermal Environment	"thermal comfort" OR "temperature" OR "thermal sensation" OR "thermal satisfaction"	Thermal discomfort (too cold); Thermal discomfort (too warm)	Thermal alliesthesia	Cooling fan; Personal heater
Acoustic Environment	"acoustic comfort" OR "noise" OR "background speech" OR "irrelevant speech" OR “speech distraction” OR “psychoacoustics”	Too loud; Too quiet; Annoying non-speech sounds; Annoying speech	Valuable speech (work-related); Valuable speech (non-work-related)	Headphones; Time crafting; Spatial crafting
Luminous Environment	“lighting" OR "light quality" OR "daylighting" OR "access to daylight" OR "natural light" OR "access to natural light"	Insufficient light; Glare; Insufficient access to daylight	Interest-evoking lighting	
Spatial Layout	"office layout" OR "office design" OR "workplace layout" OR "workplace design" OR "workspace layout" OR "workspace design")	Perceived crowding; Lack of privacy; Auditory distractions; Visual distractions; Isolation	Valuable social interactions (work-related); Valuable social interactions (non-work-related)	Time crafting; Spatial crafting
Biophilic Design	"biophilic design" OR "biophilia" OR "interior plants" OR "indoor plants" OR "nature-based design" OR "nature views" OR "views of nature"		Interior plants; Interior water features; Design which evokes nature	

Aesthetic Design	"aesthetic design" OR "aesthetics" OR "beauty"		Aesthetically-pleasing design	
Ergonomic Design	"ergonomics" OR "ergonomic quality" OR "furniture"	Uncomfortable furniture; Requirement for prolonged period of sitting		
Privacy / Crowding	"privacy" OR "crowding" OR "density"	Lack of visual privacy; Lack of auditory privacy; Perception of crowding		
Autonomy / Control	"autonomy" OR "individual environmental control" OR "local environmental control" OR "personal comfort system" OR "personal comfort device" OR "activity-based working" OR "non-territorial office" OR "flexi office" OR "flexible working" OR "agile working"	Lack of autonomy; Lack of control		Cooling fan; Personal heater; Headphones; Time crafting; Spatial crafting
Territoriality / Ownership	"psychological comfort" OR "territoriality" OR "appropriation" OR "ownership" OR "personalisation" OR "personalization"		Perceptions of ownership; Perceptions of belonginess	

1. The titles, abstracts, and keywords of research articles were searched with the keywords. All factor-specific search strings were followed by "AND TITLE-ABS-KEY ("wellbeing" OR "well-being" OR "health" OR "productivity" OR "job performance") AND TITLE-ABS-KEY ("workplace" OR "office" OR "workspace"))". To prioritise review papers published since 2010, we added "AND DOCTYPE (re) AND PUBYEAR > 2009" to the search string in a second round of searches.