

An evaluation of the impact of the office environment on productivity

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An Evaluation of the Impact of the Office Environment on Productivity

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Abstract

Purpose: This study developed a validated theoretical framework for the evaluation of office productivity which included components to represent both the physical and the behavioural environment. It is proposed that by adopting such an approach, insights into the dynamic nature, or connectivity, of office environments can be established. The main objective of this research was to investigate the effects of the office environment on its occupant's perceived productivity.

Design/methodology/approach – The study's strength is that it is based on two sizable data sets. The data collected consists of data about the physical characteristics of the office environment and data pertaining to the behavioural environment.

Findings – Results are analysed for specific work patterns (Laing *et al*, 1998), to establish meaning and relationships. In all of the four work patterns evaluated it was found that interaction was perceived to be the component to have the most positive affect on productivity and distraction was perceived to have the most negative. It is proposed that the results in this paper will provide support for the hypothesis that it is the behavioural components of the office environment that have the greatest impact on office productivity.

Research Implications - This research establishes that to truly appreciate office productivity there is a need to further understand the behavioural environment. Whilst this research evaluates different work styles and office productivity, there is a possibility to extend this to investigate personality and team role types.

Originality/value – This study establishes that it is the behavioural environment that has the greatest impact on office productivity. It demonstrates that it is the dynamic elements of the office environment, interaction and distraction that are perceived as having the greatest positive and negative influences on self assessed productivity.

Key words: Office Environment, Office Layout, Office Productivity, Work Styles, Factor Analysis.

Article Type: Research Paper¹

¹ This paper was originally included in the COBRA Conference, Atlanta, September, 2007

1.1 Introduction

The drive for greater efficiency of property provision, and ultimately cost reduction, is further fuelled by a Royal Institution of Chartered Surveyors (RICS)ⁱ report – *Property in business – a waste of space?* (Bootle & Kalyan, 2002). The report claims that UK businesses are throwing away £18 billion a year through the inefficient use of space. The report proposes that whilst property is often the second highest cost after wages, it is rarely on the boardroom agenda. Whilst Bootle and Kalyan (2002) establishes that £6.5 billion a year can be saved by adopting new working practises such as “hot-desking”, the main push towards new work methods is based on reduced costs, rather than new work methods to improve business performance.

If the real estate or the facilities operations are to be seen by the organisation as more than a cost cutting departments, then it is important to demonstrate performance metrics in more than cost cutting terms. Ideally the real estate and facilities departments should link their performance measurements to those of the organisation, thereby demonstrating the impact of the real estate and facilities on the performance of the organisation.

When discussing the office environment this paper will adopt the terms, the physical environment and the behavioural environment. The physical environment consists of components that relate to the office occupiers ability to physically connect with their office environment. The behavioural environment consists of components that relate to how well the office occupiers connect with each other, and the impact the office environment can have on the behaviour of the individual.

1.2 Office Productivity

The main body of literature that attempts to link office environments and productivity largely addresses the physical environment. Whilst there appears to be no universally accepted means of measuring office productivity, there does appear to be acceptance that a self-assessed measure of productivity is better than no measure of productivity (Whitley *et al*, 1996; Oseland, 1999 and 2004; Leaman and Bordass, 2000).

The attempts made to link the physical environment with the productivity of its occupant's falls into two main categories: those of office layout and office comfort. The literature relating to the office layout appears to revolve around two main debates: those of open-plan verses cellular offices, and the matching of the office environment to the work processes. It could be argued that the open-plan debate has led to cost reduction, as the prevailing paradigm with regards to office environments. Also, matching office environments to work processes requires a greater understanding of what people actually do when in the office environment, which is still a subject of much debate. It must be noted that much of the physical environment literature reviewed lacked any theoretical framework, and where empirical evidence was provided the sample sizes tended to be relatively small: Leaman and Bordass (2000) and Oseland (2004) being notable exceptions.

Research that attempts to address the behavioural environment tends to be at the theoretical and anecdotal stage, with little supporting empirical evidence, a notable exception being Olson (2002). However, there appears to be a growing awareness of the impact of the behavioural environment on occupants' productivity. Established in the literature review is the potential tension that can exist in the office environment between individual work and group work. If the office environment is to act as a conduit for knowledge creation, and knowledge transfer, then offices need to allow

both collaborative work and individual work to coexist without causing conflict between the two.

A wide range of papers, relating to office productivity, are collected together in "*Creating the Productive Workplace*" (Clements-Croome, 2005). The book is a valuable contribution to the office productivity debate, as it pulls together a number of leading authors work into a definitive key text. The book summarises the current state office productivity research with the chapters relating to the physical environment being more evidence based, and the chapters relating to the behavioural environment being more conceptual and anecdotal.

1.3 Research Approach

The main aims of this study can be summarised as follows:

- Develop a theoretical framework to represent office productivity, consisting of both physical and behavioural components.
- Demonstrate that it is the behavioural components of interaction and distraction that have the greater impact on office productivity.

The first dataset was obtained from a research project for a local authority research forum. The data were collected using a paper based questionnaire survey. In total 10 local authorities took part in the research project, with responses from 26 offices. The actual number of respondents was 996 from a population of 4,338 office occupants.

The second data set was obtained from the private sector, through a piece of contract research. This additional dataset provided an opportunity to test the findings of the first dataset. The data set was collected from one company consisting of four main buildings, which formed the company's head office. The total number of head office staff was 800. The data were collected using an online questionnaire with a response rate of 53%, i.e. 422 respondentsⁱⁱ.

1.4 Model development of office productivity

The data from both surveys were used as a basis to develop a model and subsequent statistical analysis techniques. Factor analysis was used as the main technique to develop an understanding of the underlying concepts of office productivity.

To develop a further understanding and an appreciation of the application of factor analysis, then it would be beneficial to explore a few definitions.

Definitions:

"It is a mathematically complex method of reducing a large set of variables to a smaller set of underlying variables referred to as factors." (de Vaus, 1999, p257)

Whilst this definition by de Vaus (1999) summarises the essence of factor analysis, it does not explain to the researcher the purpose of reducing variables to factors.

Coakes and Steed (2001) confirm factor analysis as a data reduction technique, but extend this definition to include the identification of an underlying structure of the variables.

"Factor analysis is a data reduction technique used to reduce a large number of variables to a smaller set of underlying factors that summarise the essential information contained in the variables. More frequently factor analysis can be used as an exploratory technique when that the researcher wishes to summarise the structure of a set of variables."(Coakes & Steed, 2001, p155)

Coakes and Steed (2001) also propose the nature of factor analysis as being an exploratory technique to enable the researcher to establish an understanding of the underlying structure of the variables.

The definition of factor analysis proposed by Hair *et al* (1995) is probably more explicit than the previous definitions, as it explains how the underlying dimensions or factors are identified, i.e. by inter relationships (correlations) between the variables.

*"Factor analysis is a generic name given to a class of multivariate statistical methods whose primary purpose is to define the underlying structure in a data matrix. Broadly speaking, it addresses the problem of analysing the structure of the interrelationships (correlations) among a large number of variables (e.g., test scores, test items, questionnaire responses) by defining a set of common underlying dimensions, known as **factors**."* (Hair *et al*, 1995, p90)

Since the aim of this research is to develop an identification of structure, rather than develop predictive relationships, then this supports the use of factor analysis.

Factor analysis was conducted on three separate data sets. They were the local authority data set, the private sector dataset, and finally a combined data set (Haynes, 2005). The results of the combined dataset can be seen in Table 1.

Table: 1 Four components of office productivity, and associated reliability, created from combined dataset and Eigan value set at 1.

Factor	Name	Attributes	Cronbach's alpha
All			0.95
1	Comfort	Ventilation, heating, natural lighting, artificial lighting, décor, cleanliness, overall comfort, physical security,	0.89
2	Office layout	Informal meeting areas, formal meeting areas, quiet areas, privacy, personal storage, general storage, work area - desk and circulation space	0.89
3	Interaction	Social interaction, work interaction, creative physical environment, overall atmosphere, position relative to colleagues, position relative to equipment, overall office layout and refreshments	0.88
4	Distraction	Interruptions, crowding, noise	0.8

The application of factor analysis allowed 27 evaluative variables to be reduced to four distinct components. The components Comfort and Office Layout represent the physical environment, and the components Interaction and Distraction represent the behavioural environmentⁱⁱⁱ.

Once robust components had been established the results of the combined data sets were exposed to further statistical analysis.

1.5 Discussion of Results

1.5.1 Introduction

This discussion of results aims to use the four components, previously derived, as new evaluative variables. The components will be used as the basis of analysis, set against the context of the four different work patterns; individual process, group process, concentrated study and transactional knowledge (Laing *et al*, 1998). The work pattern samples were established as subsets of the total dataset (Table 2).

Table 2 Work patterns adopted for this study

Way of Working	Flexibility (Autonomy)	Time with Colleagues (Interaction)	Sample Size
Individual Process	Very Low-Average	< 60 %	606
Group Process	Very Low-Average	> 60 %	425
Concentrated Study	High-Very High	< 60 %	252
Transactional Knowledge	High-Very High	> 60 %	116

Exploratory data analysis techniques will be adopted to evaluate the components within each of the four work patterns. The aim is to establish which of the four components, for each of the work patterns, has the most impact on the office occupiers' productivity, and to establish if the effect is positive or negative.

Hypothesis:

It is the behavioural components of office productivity that have a greater effect on productivity than the physical components. The aim of hypothesis was to establish if different forms of communication, specifically conversation, are the currency of a productive office. Therefore it will be factors that enable interaction to occur, that will be seen as the factors that have the most positive impact on office productivity.

This section will apply exploratory data analysis techniques to evaluate the hypothesis in the context of each of the four defined work patterns.

The term exploratory data analysis is used as this section aims to summarise data, in a tabulated and graphical form, and establish relationships within each work pattern, which may not be apparent in the raw data (Hussey & Hussey, 1997).

The format of the analysis for each of the four work patterns is the same. Firstly, the demographic data, which is established from the categorical questions, is presented in a tabulated format. The interpretation of the demographic data allows a profile of the work pattern type to be established. Secondly, the evaluative variables, the four components of comfort, office layout, distraction and interaction, are presented in a box plot format with accompanying analysis and interpretation^{iv}.

1.5.2 Individual process work categorical results

The individual process worker category is defined as occupiers that spend less than 60% of their time with colleagues, and have very low - average degree of flexibility to work where and how they wish. The demographic results for individual process workers can be seen in Table 3.

Table 3 Demographic results for individual process workers

Type of Office	Cellular	16
	Open Plan	83
		1
Total		100
Dedicated Desk	Yes	96
	No	4
	Total	
Time in the Office	0-20%	1
	21-40%	7
	41-60%	16
	61-80%	16
	81-100%	60
	Total	
Variety of tasks undertaken in the office	Very Low	2
	Low	9
	Average	49
	High	32
	Very High	8
	Total	

Whilst the results show that the majority of individual process workers work in open-plan offices (83%), it should be noted that a small percentage report to work in cellular offices (16%). The results also indicate that there is virtually no flexible working in the office, with 96% of individual process workers reporting to have a dedicated desk. The results offer some support to the notion that the office environment for the individual process worker can be classified as the hive office organisation (Laing *et al*, 1998).

"The hive office organization is characterized by individual routine process work with low levels of interaction and individual autonomy. The office worker sits at simple workstations for continuous periods of time on a regular 9 to 5 schedule (variants of this type include 24-hour shift working)". (Laing et al, 1998, p21)

However, there are signs that some flexibility exists outside the office, with 24% of respondents reporting that they spend less than 60% their time in the office, but the majority of individual process worker respondents report to spend more than 60% of their time in the office (76%). When in the office, 60 % of individual process workers report to be undertaking very low to average variety of tasks. This result supports the notion that individual process workers undertake repetitive work (Laing *et al*, 1998).

1.5.3 Individual process work evaluative variables

The relative distributions for each of the four components for the work pattern individual process work can be seen in Figure 1.

WPATTERN= Individual Process Work

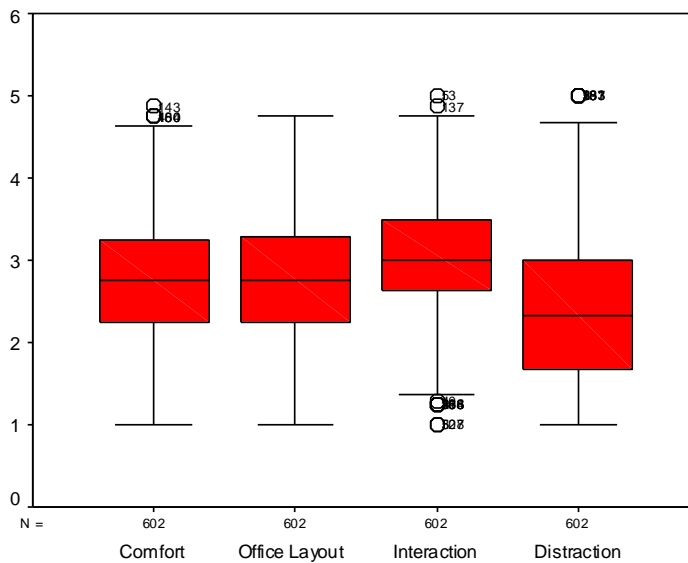


Figure 1 Box plots of evaluative variables for individual process work

The results for comfort and layout produce similar distributions with a slightly skewed distribution towards the negative, and both have median values of 2.75. This could be interpreted as a level of dissatisfaction with the layout of the office and the comfort systems it contains. The interaction results, with a median of 3.0, tend to indicate a neutral response with the inter-quartile range being around the neutral point. The fourth component (distraction) has the least median value of all the four factors (2.33), and clearly illustrates a negatively skewed distribution with an upper quartile value of 3.0. Comparison of the four components indicates that the distraction component appears to be having the most effect on productivity, that effect being relatively more negative. The sub components of distraction are crowding, noise and interruptions. There is a requirement for clear strategies to be adopted to minimise the negative effect on individual process workers productivity.

The results indicate that when it comes to individual process workers, there is a clear opportunity to improve productivity by considering the physical components of the office, those being office comfort and office layout. The proposal that this type of worker can work in a hive format layout, with limited control over heating, lighting and ventilation etc, should be questioned (Laing *et al*, 1998).

The dynamic component of distraction reveals an issue that may be addressed by considering the office protocols (Sims, 2000; Brennan *et al*, 2002). Since individual process workers have little flexibility in the office environment it is important the office environment is actively managed to support the occupiers in their work (Bradley, 2002; Laframboise *et al*, 2003).

The results question the requirement for individual process workers to be constantly in the office, since they spend relatively little time interacting with colleagues. Whilst it is acknowledged that this proposal would question the workplace culture (Turner & Myerson, 1998), it is supported by other research, which established that home-based contact centre workers produced higher productivity than comparable contact centre workers (Wright, 2002). By considering flexible working for individual process workers the negative effect of the component distraction could be reduced (Olson, 2002).

To enhance the positive effects of interaction, consideration should be given to the creation of interactive areas such as break out space (Peterson & Beard, 2004). This result is in contrast to the purely regimented hive layout for individual process workers as proposed by Laing *et al* (1998).

The results for the individual process workers support the hypothesis that it is the behavioural components of the office environment that have the greatest effect on productivity.

1.5.4 Group process work categorical results

The group process worker category is defined as occupiers that spend more than 60% of their time with colleagues, and have very low - average degree of flexibility to work where and how they wish. The demographic results for group process workers can be seen Table 4.

Table: 4 Demographic results for group process workers

Type of Office	Cellular	18
	Open Plan	81
		1
Total		100
Dedicated Desk	Yes	97
	No	2
		1
Total		100
Time in the Office	0-20%	0
	21-40%	3
	41-60%	4
	61-80%	13
	81-100%	80
	Total	
Variety of tasks undertaken in the office	Very Low	3
	Low	4
	Average	46
	High	33
	Very High	14
	Total	

Whilst the results show that the majority of group process respondents work in open-plan offices (81%), it should be noted that a small percentage report to work in cellular offices (18%). The results also indicate that there is virtually no flexible working in the office, with 97% of group process workers reporting to have a dedicated desk. There is little evidence of flexibility outside the office, with only 7% of respondents reporting that they spend less than 60% of their time in the office, and the majority of group process worker respondents report to spend more than 60% of their time in the office (93%). When in the office, 46% of group process workers report to be undertaking average variety of tasks and a further 47% report to be undertaking high to very high variety of tasks. However, the results generally support the proposal that group process work be undertaken in an open-plan environment (Laing *et al*, 1998).

"The den office organization is associated with group process work, interactive but not necessarily highly autonomous. The space is designed for group working with a range of several simple settings, typically arranged in the open-plan or group room."
(Laing *et al*, 1998, p23)

1.5.5 Group process work evaluative variables

The relative distributions for each of the four components for the work pattern group process work can be seen in Figure 2.

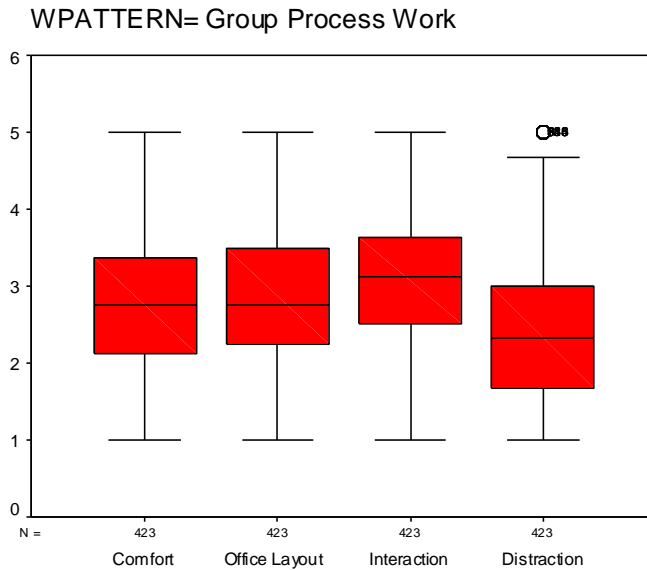


Figure 2 Box plots of evaluative variables for group process workers

The median values for comfort and layout are both the same, with a value of 2.75, indicating slightly skewed negative distributions, although the upper quartile is more positive for the office layout results than the comfort results with values of 3.5 and 3.38 respectively. These results indicate that there is an opportunity to improve office productivity by reviewing the office comfort and layout provided for group process workers.

The interaction results appear to be the most positive for the group process workers with a median of 3.13 and an upper quartile result of 3.63. It is understandable that the group process workers value interaction as they spend more than 60% of their time with colleagues. The fourth component (distraction) has the most negatively skewed distribution and has a median value of 2.33 and an upper quartile value of 3.0. The distraction results, for the group process workers, follow the same profile as the individual process workers indicating a common issue for both individual and group process workers.

Comparing the four components it can be seen that the interaction component results have the most positive distribution and the distraction component has the most negative results, thereby providing supporting evidence for the hypothesis.

The results indicate a profile for the group process worker that consists of 93% of respondents spending more than 60% of their time in the office and spending more than 60% of their time interacting with colleagues. This profile suggests that the group process worker is largely location required. This requirement, to be constantly in the office, clearly puts a high demand on ensuring that the comfort and the office layout are designed correctly for group activity (Sims, 2000). Group process work largely involves other office occupiers; therefore consideration should be given to the provision of quiet, private areas (Peterson & Beard, 2004)

Whilst office layout can greatly improve the effect of distraction and interaction, there comes a point where any further improvement can only be achieved by ensuring the people know how to use the space. There is a requirement for clear protocols about

how the space is to be used and how people should conduct themselves in the spaces created (Brennan *et al*, 2004; Sims, 2000). Failure to undertake this kind of awareness training can lead to unnecessary dissatisfaction, simply because people were never shown how to use the office environment (Pugsley & Haynes, 2002).

It can be concluded that the results for group process workers support the hypothesis that it is the behavioural components of the office environment that have the greatest effect on productivity.

1.5.6 Concentrated study work categorical results

The concentrated study worker category is defined as occupiers that spend less than 60% of their time with colleagues, and have high – very high degree of flexibility to work where and how they wish. The demographic results for group process workers can be seen in Table 5.

Table 5 Demographic results for concentrated study workers

Type of Office	Cellular	23
	Open Plan	76
		1
Total		100
Dedicated Desk	Yes	91
	No	8
		1
Total		100
Time in the Office	0-20%	3
	21-40%	15
	41-60%	32
	61-80%	25
	81-100%	25
Total		100
Variety of tasks undertaken in the office	Very Low	1
	Low	4
	Average	40
	High	45
	Very High	10
Total		100

The concentrated study respondents report more cellular offices than individual process and group process workers (23%), although the majority of concentrated study workers work in open-plan (76%). This result is in contrast to the proposal that concentrated study workers should work in cellular offices (Laing *et al*, 1998).

The results for the time spent in the office indicate that 50% of the concentrated study respondents spend less than 60% of their time in the office. This is an indication that not only do concentrated study workers perceive themselves to have more flexibility than the individual process and group process respondents, but that they also act on that flexibility. The results offer some support to the proposal that concentrated study workers can occupy a range of different locations (Laing *et al*, 1998).

"The cell office organization is for individual concentrated work with little interaction. Highly autonomous individuals occupy the office in an intermittent irregular pattern with extended working days, working elsewhere some of the time (possibly at home, at clients, or on the road)." (Laing et al, 1998, p22)

With 50% of concentrated study respondents spending less than 60% of their time in the office there appears to be an opportunity to undertake flexible working practices such as hot-desking or hotelling, although the results for dedicated desks indicate that only a small percentage undertake flexible working practices within the office environment, with only 8% reporting to have a non dedicated desk.

When in the office, 40% of concentrated study respondents report to be undertaking an average variety of tasks, and a further 55% report to be undertaking high to very high variety of tasks. Compared with the individual process and the group process workers, the concentrated study workers report the most variety of tasks, although the tasks are largely undertaken on an individual basis.

1.5.7 Concentrated study work evaluative variables

The relative distributions for each of the four components for the work pattern concentrated study work can be seen in Figure 3.

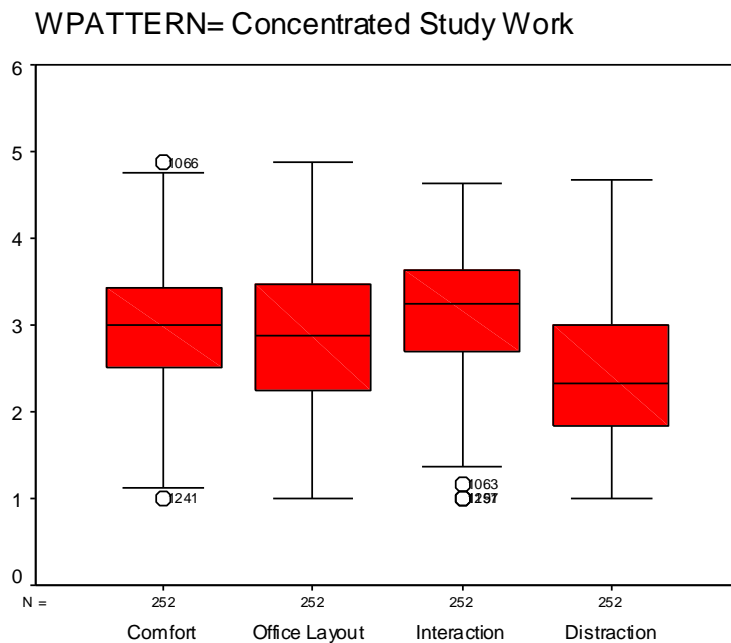


Figure 3 Box plots of evaluative variables for concentrated study work

The distribution for the comfort component indicates a relatively even distribution with median value of 3.0 and an inter-quartile range between 2.13 and 3.38. The office layout component has a slightly more negative distribution than the comfort distribution, with a median of 2.88. Although 50% of concentrated study respondents spend less than 60% of their time in the office, when in the office the comfort and layout results indicate that it is not an environment designed to enhance their productivity.

Although the concentrated study worker category is defined as office occupiers that spend less than 60% of their time with colleagues, the interaction distribution is the most positive for the concentrated study respondents, with a median of 3.25 and an upper quartile result of 3.63. This is an indication that whilst concentrated study

workers largely work on their own, interactions are valued as having a positive effect on their productivity; this could be a chance conversation in a corridor or over a coffee (Haynes & Price, 2004).

Of all the components, the distraction component has the most negatively skewed distribution, with a median value of 2.33 and an upper quartile value of 3.0, indicating distraction to be the component to having the most effect on perceived productivity (Olson, 2002). Comparing the four components it can be seen that the interaction component results have the most positive distribution and the distraction component has the most negative results.

The results indicate a poor space utilisation with only 25% of concentrated study respondents spending between 81-100% of their time in the office, and 91% of concentrated study respondents reporting to have a dedicated desk. With these kinds of results it is understandable why FM managers see that cost reduction can be achieved by providing less space (Haynes *et al*, 2000). The opportunities to save space, and ultimately cost reduction, are further supported by The RICS report "Property in Business a Waste of Space" which claims that:

"Hot desking "and other new working practices could save British business a further £6.5 billion a year." (Bootle & Kalyan, 2002)

Probably the most appropriate workplace strategy for a concentrated study worker would be hotelling, since they have the flexibility to work in a manner that is appropriate to their needs. Therefore they could plan and book concentrated study areas as and when they were required.

The results indicate a mismatch between concentrated study office occupiers and their office layout, as evidenced by the negative 2.88 median result (Mawson, 2002). A possible solution, to improve the match between concentrated study workers and their office layout, would be to create an environment that includes "commons and caves" (Hurst, 1995; Steele, 1981). The balance for commons and caves would probably be more biased toward the caves, as concentrated study workers tend to undertake work on an individual basis. However, evidenced by the results, concentrated study workers perceive interaction as the most positive effect on their productivity and so there is a requirement for common areas that allow this interaction to take place, (Peterson & Beard, 2004). The adoption of common areas could also address the social isolation often identified by people that spend a large part of their time working away from the office environment (Downer, 2001).

The results for the concentrated study workers offer support for the hypothesis that it is the behavioural components of the office environment that have the greatest effect on productivity.

1.5.8 Transactional knowledge work categorical results

The transactional knowledge worker category is defined as occupiers that spend more than 60% of their time with colleagues and have high – very high degree of flexibility to work where and how they wish. The demographic results for transactional knowledge workers can be seen in Table 6.

Table: 6 Demographic results for transactional knowledge workers

Type of Office	Cellular	20
	Open Plan	79
		1
	Total	100
Dedicated Desk	Yes	96
	No	2
		2
	Total	100
Time in the Office	0-20%	2
	21-40%	3
	41-60%	22
	61-80%	22
	81-100%	50
	Total	100
Variety of tasks undertaken in the office	Very Low	0
	Low	1
	Average	23
	High	53
	Very High	23
	Total	100

The majority of transactional knowledge respondents report to work in open-plan office environments (79%). This result is similar to all the other work pattern results indicating that for all work patterns the open-plan environment is the dominant office type.

Whilst transactional knowledge workers perceive themselves to have a high – very high degree of flexibility to work where and how they wish, they do not appear to exercise this flexibility by working outside the office with 72% of reporting to spend more than 60% of their time in the office, and the modal category being 81-100% time in the office (50%).

The majority of transactional knowledge respondents report to be undertaking high to very high variety of tasks (76%), with the model category being high variety of tasks (53%). In comparison to the other work patterns the transactional knowledge respondents report to undertake the most variety of tasks. The results generally support the proposal that transactional knowledge workers are dynamic and interactive (Laing *et al*, 1998).

"The club office organization is for knowledge work: both highly autonomous and highly interactive. The pattern of occupancy is intermittent and over an extended working day." (Laing et al, 1998)

However, only 2% of transactional knowledge worker respondents report to work at a non-dedicated desk, which is in contrast to the proposal that the office environment for transactional knowledge workers should be a mixture of shared settings (Laing et al, 1998).

1.5.9 Transactional knowledge work evaluative variables

The relative distributions for each of the four components for the work pattern transactional knowledge work can be seen in Figure 4.

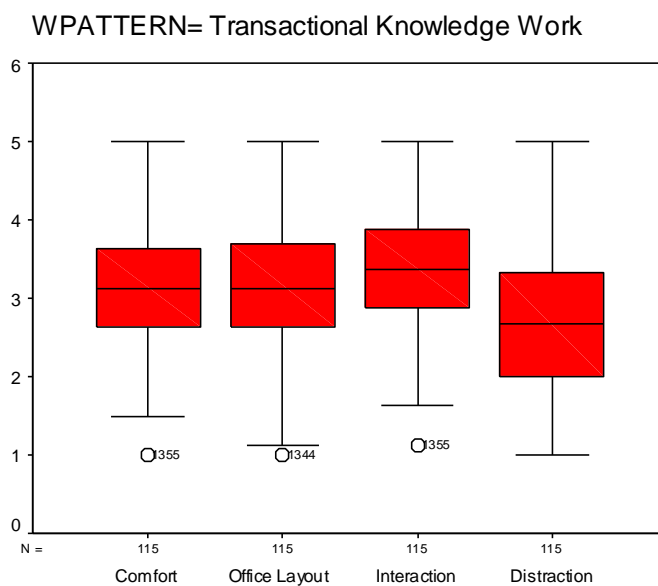


Figure 4 Box plots of evaluative variables for transactional knowledge work

The distributions for the comfort and office layout component have the same median value of 3.13, indicating a slight positively skewed response. These results are higher than any other work pattern, indicating that the transactional knowledge workers perceive their physical environment in more positive terms. It should also be noted that whilst transactional knowledge workers are defined as having flexibility in where they work, 72% report to spend between 61-100% of their time in the office. Therefore there is a clear indication that the office environment is where the transactional knowledge work takes place, as opposed to outside the office. This result places greater emphasis on the need for the design of an enabling environment (Stallworth & Klenier, 1996).

The interaction component has the highest median value (3.44) giving an indication of the value placed on interaction for transactional knowledge workers. The relatively high score of interaction can be understood, once one considers the process of transactional knowledge work. This work pattern is based on knowledge workers collaborating in a range of different groups or teams. The purpose is to transfer and create new knowledge, as knowledge creation can be considered as the output of a modern office environment (Clark et al, 2004).

The distraction component has the most negatively skewed distribution, with a median value of 2.67 and an upper quartile value of 3.33. This result demonstrates the tension that exists between interaction and distraction, (Heerwagen *et al.*, 2004). The transactional knowledge workers value interaction but see distraction as having a negative effect on their productivity. This creates a paradox, as one person's interaction is another person's distraction. To resolve this, consideration needs to be given to how transactional knowledge workers interact in the office, the type of office space provided, and the flow and dynamics of the office (Cornell, 2004).

The profile of the transactional knowledge worker has previously identified the dynamic nature of transactional knowledge work, and the requirement to act as part of a high performance team. This collaborative approach requires the office layout to consist of a range of shared settings (Becker & Steele, 1995)

Achieving a multi-activity environment does not necessarily mean that there is a requirement for more space, since 96% of transactional knowledge workers have dedicated desks and 27% of transactional knowledge workers spend less than 60% of their time in the office there are opportunities for more flexible work patterns and more use of shared areas. The aim is not purely space reduction, but to have the right kind of space, thereby enabling an increase in productivity. Central to improving the office environment for transactional knowledge workers is the understanding of the social dynamic, the way that people interact with each other, and ensuring an environment is created to support those interactions (Nathan & Doyle, 2002). The matching of people to their office environment, with the aim of creating a high performance workplace, has been previously referred to as organisational ecology (Becker & Steel, 1995).

This people-centric approach to creating office environments also acknowledges that it is the empowered knowledge worker that is the "intellectual capital" of the organisation. Eltringham (1998) goes on to argue that it is the "soft issues" that keep people happy in their work, and the point is made that:

"Training, personal development, flexible hours, good working relationships and a pleasant environment are just as important as a fat pay cheque." (Eltringham, 1998, p24)

It can be concluded that the results for transactional knowledge work support the hypothesis that it is the behavioural components of the office environment that have the greatest effect on productivity.

1.6 Conclusions

This paper has analysed the supporting evidence for the hypothesis that it is the behavioural components that have a greater impact on perceived productivity than the physical components. The components interaction and distraction are constantly perceived as the components that have the most positive and most negative effect, respectively, on perceived productivity. The results are consistent in that they are repeated in all of the four work patterns analysed.

The results for the individual process workers indicate that the physical components of comfort and office layout are not enhancing their productivity. If the individual process worker is to constantly work in the office environment then further

consideration needs to be given to their physical needs. Alternatively, an opportunity exists to allow individual process workers to work flexibly away from the office environment. However, this approach would require an accompanying workplace culture.

The group process workers are required to be constantly in the office since they work with other group members. It is therefore important to ensure that the physical environment matches the group process workers' needs. Further consideration needs to be given to increased individual control of the comfort systems and the provision of quiet private spaces. In addition, to ensure that the office environment works for the group process workers, office protocols need to be developed and managed.

The concentrated study workers offer the most opportunity for flexible working. The results indicate an inefficient use of office space with the majority of concentrated study workers having a dedicated desk, even though they are not constantly in the office environment. A possible workplace strategy for the concentrated study workers would be hotelling. However, the concentrated study worker results indicate that when in the office environment they value interaction with other office workers. There is clearly a requirement for space to support both individual and collaborative work styles.

The results for transactional knowledge workers indicate that this type of office worker requires the office environment to be adaptive. Effectively, this means an office environment that has a range of different settings, which allows the transactional knowledge worker to move around and match the office space to meet their specific needs. The results indicate a need for an environment that enables the social dynamics of interaction, thereby facilitating the creation, and transference, of knowledge.

The findings in this paper have implications for the office manager, as there is clearly a requirement to proactively manage the behavioural environment. The optimum balance between interaction and distraction has to be reached, and this will require the adoption of office protocols (Sims, 2000; Brennan *et al*, 2002). The physical environment can also play a role in achieving the optimum balance, by creating different kinds of work space, such as collaborative work space and space for private individual work (Peterson & Beard, 2004). The proportions of space allocation will be very much dependent on the adopted work pattern within the office environment.

This study serves to broaden the office productivity debate, by identifying the need for a greater understanding of the cultural elements (Turner & Myerson, 1998; Haynes, 2007b) and the behavioural components within an office environment (Nathan & Doyle, 2002; Haynes, 2007c).

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ⁱ The Royal Institution of Chartered Surveyors supports 140,000 worldwide members operating out of 146 countries.

ⁱⁱ The high response rate in this research can be accredited to two elements. The offices in the local authorities were part of a research forum and therefore there was a invested interest in returning the questionnaires. The data for the offices in the private sector were collected by online questionnaire which significantly increased the response rate.

ⁱⁱⁱ A more detailed account of the model development for office productivity can be seen in Haynes (2007a)

^{iv} The box plot is an appropriate means for presenting the data, as it allows the four distributions to be presented along side each other, thereby allowing, at a glance, variation in the central level and the spread of the data to be established (Dunleavy, 2003).