

Impact of workplace connectivity on office productivity

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Impact of Workplace Connectivity on Office Productivity

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Abstract

Purpose: This paper aims to establish if office occupiers, who adopt different work patterns, can be segmented based on differences of perceived productivity with regards to the physical environment and the behavioural environment.

Design/methodology/approach – Components of office productivity were used in an office productivity model with categorical data enabling a unique opportunity to undertake an analysis of office occupiers by work process type.

Findings – The four distinct evaluative components used were comfort, office layout, interaction and distraction. The components were subsequently used for more detailed statistical analysis. This study establishes that statistical differences exist between the work styles under investigation.

Research Implications - This research establishes that to truly appreciate office productivity there is a need to further understand the way that people work in offices and their specific requirements. The matching of office occupier need with space provision can only be achieved if the office occupier is involved in the creation of the office solution.

Originality/value – This study demonstrates that there is a need to consider how the office environment matches the work patterns of the office occupiers. This understanding of how the office works could be considered as establishing the office landscape or “*Officescape*”.

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

Article Type: Research Paper

1.0 Introduction

This paper aims to establish that measurement of office productivity should include 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.

This study aims to segment office occupiers based on their work style. The work styles adopted are individual process work, group process work, concentrated study work and transactional knowledge work (Laing *et al*, 1998).

- Individual process workers are largely required to be at their desk and have a low degree of interaction with their work colleagues.
- Group process workers are largely required to be at their desks but have a high degree of interaction with work colleagues.
- Concentrated study workers have a high degree of flexibility in where they work and have a low degree of interaction with their work colleagues.
- Transactional knowledge workers have a high degree of flexibility in where they work and have a high degree of interaction with their work colleagues.

Fundamentally, this research is based on the premise that a high performance workplace is created when the office environment is in alignment with the occupier work styles and the occupier perception of their office environment.

This study will report the behavioural and the physical components of office productivity for each work style. Ultimately, the study will establish how well the office environment supports the four work styles under investigation. This study measures office productivity by adopting a self assessed approach¹.

1.1 Research Approach

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

- Compare and contrast work patterns to establish if significant differences exist with regards to 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 respondents.

The questions asked were basically the same for all the twenty-seven variables under investigation.

“In your opinion, in your current office environment, what effect do the following elements have on your personal productivity?”

To assist with the data entry a five-point Likert scale was used. The options were very negative, negative, neutral, positive, and very positive. Each option was allocated a score:

1 = very negative, 2 = negative, 3 = neutral, 4 = positive, 5 = very positive

Using the score values, average values can be established for each variable or statement. Average values above 3 indicate that the office environment is having a positive effect on work performance and average values below 3 suggest that the office environment is having a negative effect on worker performance.

1.2 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. 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, 2007a). 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 environment.

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

1.3 Discussion of Results

1.3.1 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

The analysis adopted applies a range of confirmatory statistical techniques, using the four components as common metrics of analysis. This approach allows statistical comparisons to be made between the work patterns and the components.

1.3.2 Confirmatory work pattern data analysis

The aim of the analysis is to establish if there are any statistically significant results in the evaluative results for the various work patterns. The analysis adopted uses ANOVA techniques to establish if any statistically significant differences exist for each of the evaluative components and the different work patterns.

Ultimately, this section aims to establish if there are any statistically significant differences between the work patterns and their assessment of office productivity.

Hypothesis:

There is no significant difference between work patterns in terms of office productivity.

The hypothesis aims to establish if office occupiers, who adopt different work patterns, can be segmented based on differences of perceived productivity with regards to the physical environment and the behavioural environment.

1.3.3 Work pattern ANOVA results

This section of analysis aims to evaluate the four components to establish consistency of results across the four work patterns. The section will start with ANOVA results to establish significant differences between the components and the work pattern categories. Subsequently each of the four component results will be analysed to ascertain which of the work pattern categories results are significantly different.

The ANOVA results (Table 3) indicate that there are highly significant differences within the responses for comfort ($F(3,1389) = 7.377, p < 0.01$), office layout ($F(3,1392) = 8.005, p < 0.01$), interaction ($F(3,1391) = 7.801, p < 0.01$), distraction ($F(3,1389) = 5.763, p < 0.01$).

Table:3 Work pattern ANOVA results

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Comfort	Between Groups	14.789	3	4.930	7.377	.000
	Within Groups	928.172	1389	.668		
	Total	942.961	1392			
Office Layout	Between Groups	16.203	3	5.401	8.005	.000
	Within Groups	939.192	1392	.675		
	Total	955.395	1395			
Interaction	Between Groups	12.512	3	4.171	7.801	.000
	Within Groups	743.662	1391	.535		
	Total	756.174	1394			
Distraction	Between Groups	12.892	3	4.297	5.763	.001
	Within Groups	1035.663	1389	.746		
	Total	1048.555	1392			

Since the Levene statistic, as can be seen in Table 4, for office layout and interaction were $p > 0.05$ the Tukey HSD statistic was used. However since the Levene statistic for the components of comfort and distraction were $p < 0.05$, Games-Howell statistic was used (Field, 2000).

Table:4 Levene statistics for four office components

Test of Homogeneity of Variances

	Levene Statistic	df 1	df 2	Sig.
Comfort	9.385	3	1389	.000
Office Layout	2.493	3	1392	.059
Interaction	2.477	3	1391	.060
Distraction	2.808	3	1389	.038

Having established that statistical significant differences exist between the four components and the work patterns, the next part of the analysis will evaluate each of the components in turn, to identify which of the work patterns are significantly different and offer an accompanying interpretation of the results.

1.3.3.1 Comfort

The comfort component can be seen as containing two elements of comfort, those being “hard” and “soft”. The hard variables relate to the traditional environmental comfort variables of heating, lighting and ventilation, whilst the soft variables relate to the décor and cleanliness of the office environment, and also the physical security of the office occupier Haynes (2008a).

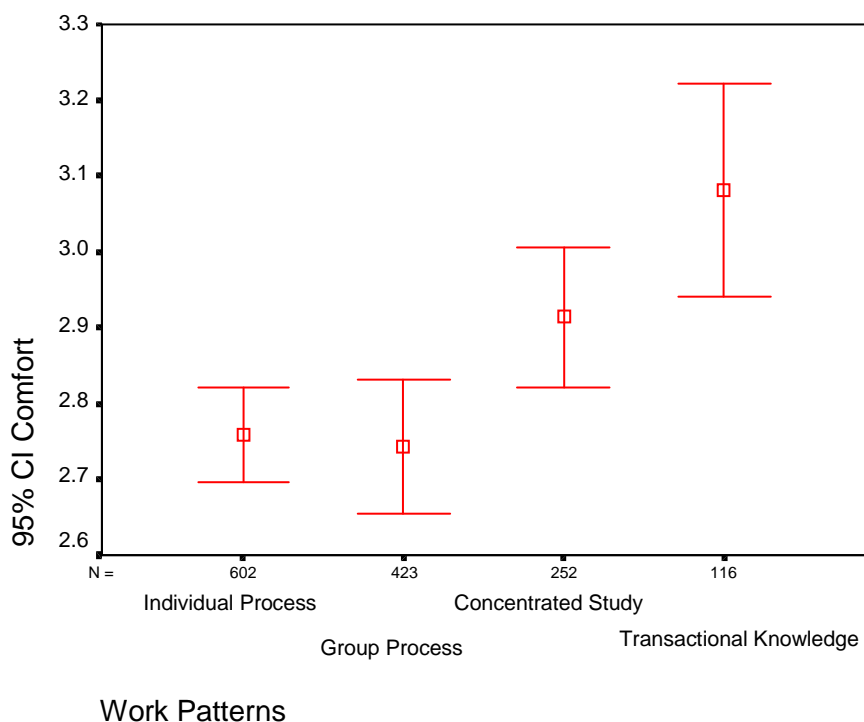


Figure 1 Error bars for comfort and work patterns

The comfort results Figure 1 indicate that the only group to perceive comfort as having a positive effect on their productivity were the transactional knowledge workers (transactional knowledge work = 3.08). Whilst the group that report comfort to be having the most negative effect on their productivity are the group process workers (group process work = 2.74).

Table:5 95% confidence interval results for comfort and work patterns

		N	Mean	95% C.I. of Mean	
				Lower Bound	Upper Bound
Comfort	Individual Process Work ¹	602	2.76	2.70	2.82
	Group Process Work ²	423	2.74	2.65	2.83
	Concentrated Study Work ^{1,2}	252	2.91	2.82	3.01
	Transactional Knowledge Work ^{1,2}	116	3.08	2.94	3.22
Total		1393	2.81	2.77	2.85

The results in Table 5 indicate that there are two highly significant different groupings (individual process work = 2.76, concentrated study = 2.92,

transactional knowledge work = 3.08, $p < 0.01$) and (group process work = 2.74, concentrated study = 2.91, transactional knowledge work = 3.08, $p < 0.01$).

The results indicate that no statistical difference exists between concentrated study and transactional knowledge respondents indicating that these two work patterns share the same view when it comes to office comfort. An explanation for this finding could be that both the concentrated study workers and transactional knowledge workers have the flexibility to work anywhere, any time. This means that if they feel uncomfortable in the office environment they can work away from the office setting, or even somewhere else in the office environment. This effectively gives the individual an element of control of their comfort in the office environment (Whitely *et al*, 1995; Whitley *et al*, 1996).

In contrast, the individual process and group process workers have no autonomy in where they work, as they are location required. It could be argued that for these groups of workers there is a higher demand of the comfort systems, as they are in the office for most of the time. This is supported by the results for the time spent in the office, with 93% of the group process workers reporting that they spend more than 60 % of their time in the office, and 76% of the individual process workers reporting that they spend more than 60 % of their time in the office.

It is worth noting that it is the group process workers who report the most negative result for the comfort of the office environment. This could be caused by the fact that not only are these workers desk bound, but they also work in groups and therefore any alteration to the comfort systems would have to be agreed on a team basis. This clearly has the possibility of conflict and ultimately compromise. This finding supports one of the conclusions of the NEW study (Laing *et al*, 1998).

“The key issue for den organisations (group process workers) is how to enable group consensus based decisions.” (Laing *et al*, 1998, p10)

These results support the notion of “*locus of control*”, that is a linkage between individuals’ perceived productivity and perceived control of the office comfort systems (Whitely *et al*, 1995; Whitley *et al*, 1996). There is a potential linkage between workplace productivity and the quality of FM service delivery (Tucker and Smith, 2008).

The statistical results show that at best the environmental comfort systems are having a neutral effect on productivity for transactional knowledge workers and concentrated study workers, and at worst they are having a negative effect on the individual process and group process workers. These results demonstrate that there is a clear need for improved comfort systems for the individual and group process workers. These results are partly supported by the NEW results (Laing *et al*, 1998).

"Existing environmental systems meet the relatively simple requirements of the hive (individual process workers) and the cell office (concentrated study workers) more easily than those of the more complex patterns of the den (group process workers) and the club (transactional knowledge workers)." (Laing et al, 1998, p8)

However, in contrast to the NEW results, the negative results for individual process workers indicate that it is inappropriate to consider the individual process workers' requirements for comfort systems to be "relatively simple".

The results also show that there are significantly different groups, and therefore there are differing requirements for the comfort systems depending on the work pattern. The implication of this finding is that when designing offices of mixed work patterns, specific attention needs to be paid to the range of demands placed on the comfort systems. This result is supported by the NEW results.

"Environmental systems should provide a higher degree of control, both for individuals and groups, than is available at present." (Laing et al, 1998, p10)

1.3.3.2 Office Layout

This component relates to office workers on different levels. The first level relates directly to the individual, such as their workarea, personal storage and the feeling of privacy in an office environment. The second level relates more to the wider office concept, such as general storage and facilities to undertake work away from the desk, such as formal, informal and quiet areas. The office layout is linked to the flow of the office, which is accounted for in the circulation space Haynes (2008b).

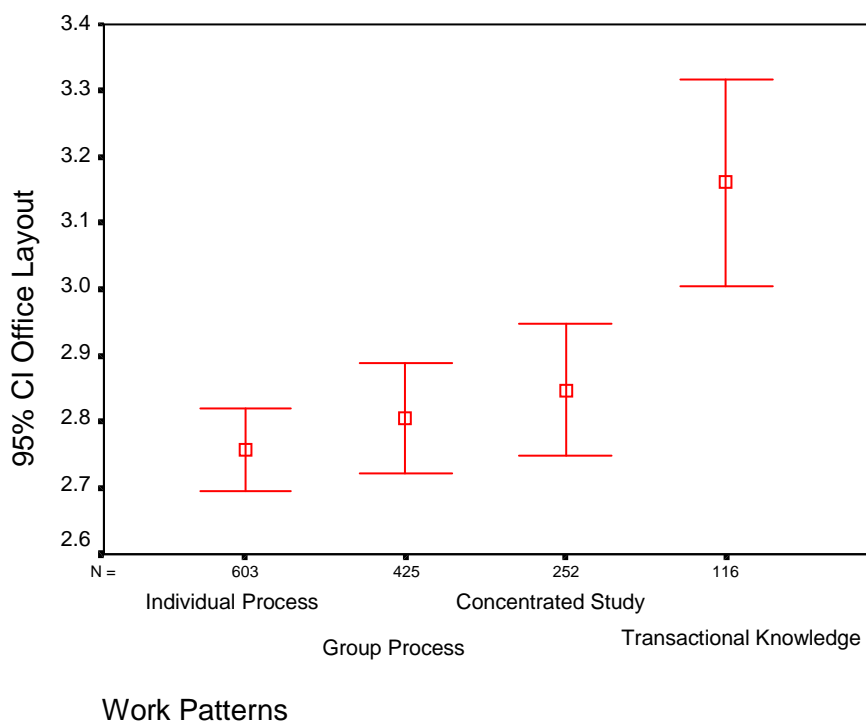


Figure 2 Error bars for office layout and work patterns

The results in Figure 2 graphically demonstrate the range of confidence intervals for office layout and work patterns. Clearly, transactional knowledge workers have the most positive mean score and the largest confidence interval. In contrast the individual process workers have the most negative mean score and the smallest confidence interval.

Table:6 95% confidence interval results for office layout and work patterns

	N	Mean	95% C.I. of Mean	
			Lower Bound	Upper Bound
Office Layout Individual Process Work	603	2.76	2.69	2.82
Group Process Work	425	2.80	2.72	2.89
Concentrated Study Work	252	2.85	2.75	2.95
Transactional Knowledge Work*	116	3.16	3.00	3.32
Total	1396	2.82	2.78	2.86

The results in Table 6 show that for the component of office layout, the transactional knowledge workers' results are positive and are significantly different from the other groups (individual process work = 2.76, group process

work = 2.8, concentrated study = 2.85, transactional knowledge work = 3.16 p<0.01).

The transactional knowledge workers define themselves as highly interactive with colleagues when in the office environment, and have the flexibility to work anywhere any place and any time. Whilst the transactional knowledge workers have the flexibility to work outside of the office, further analysis reveals that 72% of them spend more than 60 % of their time in the office. Therefore it could be concluded that they perceive that they are working flexibly within the office environment although not tied to a particular part of the office. This result indicates the dynamic nature of the transactional knowledge workers. This is supported by the result which shows that when in the office 76% of the transactional knowledge workers report to be undertaking high-very high variety of tasks. The results support the pattern of working proposed by the NEW research (Laing *et al*, 1998).

The concentrated study workers report to have the same degree of flexibility as the transactional knowledge workers, and also act on that flexibility with 50% of the respondents spending less than 60 % of their time in the office, but clearly feel that the office layout is having a negative impact on their productivity. Laing *et al* (1998) define concentrated study work as:

"High-level work carried out by talented independent individuals (isolated knowledge worker)." (Laing et al, 1998, p27)

Investigating the type of office that concentrated study workers report to be working in reveals that 23% work in cellular and 76% work in open-plan. Also 91% report to have a dedicated desk whilst 8% report to have no dedicated desk. These results appear to be in contrast to the proposed type of space layout by the NEW research.

"Highly cellular enclosed offices or individually used open workstations with high screening or partitions." (Laing et al, 1998, p27)

Whilst it is not a natural conclusion that all concentrated study workers have to have cellular offices, as the same type of environment can be created in an open-plan, it is clear that the right types of environments are not being created. Also with 50% of concentrated study workers reporting that they are in the office less than 60% of the time and only 8% reporting to not have a dedicated desk, there is clearly an opportunity to consider more shared use of desks. This would release space so that the right kind of space, i.e. more cellular type space, can be created. This approach would enable more efficient use of space with less space per person and the right kind of space (Peterson & Beard, 2004).

The groups that report office layout to be having the most negative effect on their productivity are the individual process workers and the group process workers. Both groups share the common element of perceiving that they have very low – average degree of flexibility on how and where they work. Also both groups report a certain amount of repetition in their work with 60% of individual process workers and 53% of group process workers reporting very low – average variety of tasks undertaken in the office environment. As previously identified with the comfort component, where office workers are more desk bound when in the office, there is more of an emphasis on providing the appropriate office layout solution.

Clearly the results for office layout indicate that only the transactional knowledge workers perceive the layout to be having a positive effect on their productivity, and the remaining work patterns perceive the office layout to be having a negative effect on their productivity. Duffy (2000) proposes that office design has not developed as far as was promised as in the early 1990s. The results presented for office layout support this point, and indicate that the situation may be worse than Duffy (2000) believes, with three of the four work patterns reporting a negative effect on their productivity. One observation, from the results, is that if office environments are disabling productivity, then part of the solution may be to review the design process and ensure that occupiers are consulted at an earlier stage (Burke & Chidambaram, 1999).

By considering the “*Use Phase*” of a building, and designing office environments from the occupier perspective, a number of advantages can be identified (Laframboise *et al*, 2003):

1. It establishes occupier ownership and commitment to the solution.
2. It allows the space planners a better understanding of how the occupiers use of space.
3. It offers a vehicle for managing change and occupier expectations

1.3.3.3 Interaction

This component is defined by the ability of office workers to interact on both a work level and a social level (Nathan & Doyle, 2002; Haynes, 2007c). This component is closely linked to office layout as this can be seen as an enabler of interaction with the positioning of colleagues, equipment and refreshments. These informal interaction points or “*areas of convergence*” can be seen as “*attractors*” in an office environment. These “*attractors*” draw people around the

office or building. On another level, there is the ability to interact with the space within the office; the atmosphere and the creativity within the office environment allow this to be captured (Stokols *et al*, 2002; Haynes, 2007c).

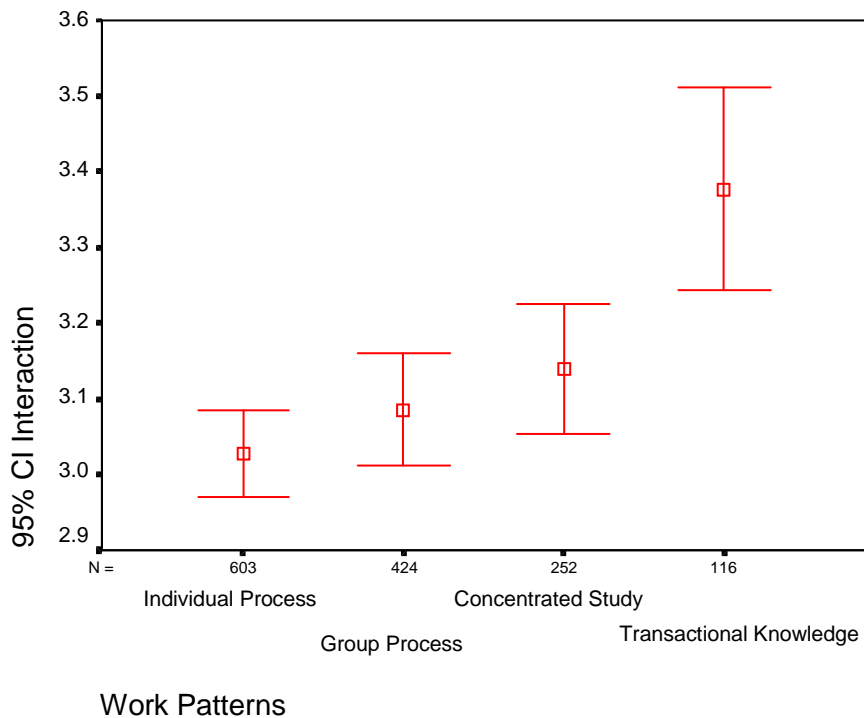


Figure 3 Error bars for interaction and work patterns

The results in figure 3 graphically demonstrate the range of confidence intervals for interaction and work patterns. Clearly, transactional knowledge workers have the most positive mean score and the largest confidence interval. In contrast the individual process workers have the least positive mean score and the smallest confidence interval. All work patterns reported that interaction in the office environment was perceived as having a positive effect on their productivity. This finding is significant, as it demonstrates that whilst the work patterns individual process work and concentrated study work spend less that 60% of their time working with colleagues in the office environment, the time they do spend with colleagues is valued.

Table:7 95% confidence interval results for interaction and work patterns

		N	Mean	95% C.I. of Mean	
				Lower Bound	Upper Bound
Interaction	Individual Process Work	603	3.03	2.97	3.08
	Group Process Work	424	3.09	3.01	3.16
	Concentrated Study Work	252	3.14	3.05	3.23
	Transactional Knowledge Work*	116	3.38	3.24	3.51
	Total	1395	3.09	3.06	3.13

As can be seen in Table 7 a significant difference exists between the transactional knowledge workers and the other work pattern categories (individual process work = 3.02, group process work = 3.1, concentrated study = 3.1, transactional knowledge work = 3.4 $p < 0.01$). The group that report office layout to be having the least positive effect on their productivity are the individual process workers.

The results show that all groupings value the concept of interaction, although in varying degrees. It is worth noting that the two groups that report the most positive results are the transactional knowledge workers and the concentrated study workers, both have in common the idea of knowledge work, with the former being group knowledge work and the latter being individual knowledge work. Whilst the results are positive for the process workers, both individual and group, they are clearly not as positive as both the knowledge worker groups.

These results illustrate the concept of “*social dynamics*” (Nathan & Doyle, 2002; Haynes, 2007c), and make the point that if offices are to be designed for maximum productivity then the dynamic nature of interaction needs to be integrated into the design of office environments. The interaction results support the proposals that the modern office environment needs to enable and encourage interaction, thereby facilitating knowledge exchange (Ward & Holtham, 2000 Haynes, 2007d).

1.3.3.4 Distraction

This component contains the variables that can disrupt an office environment by creating disablers to productive work (Mawson, 2002; Haynes, 2007c). Distraction is a function of the office layout, and is a composite of the amount of noise generated in the office, and the number of interruptions received in a working day.

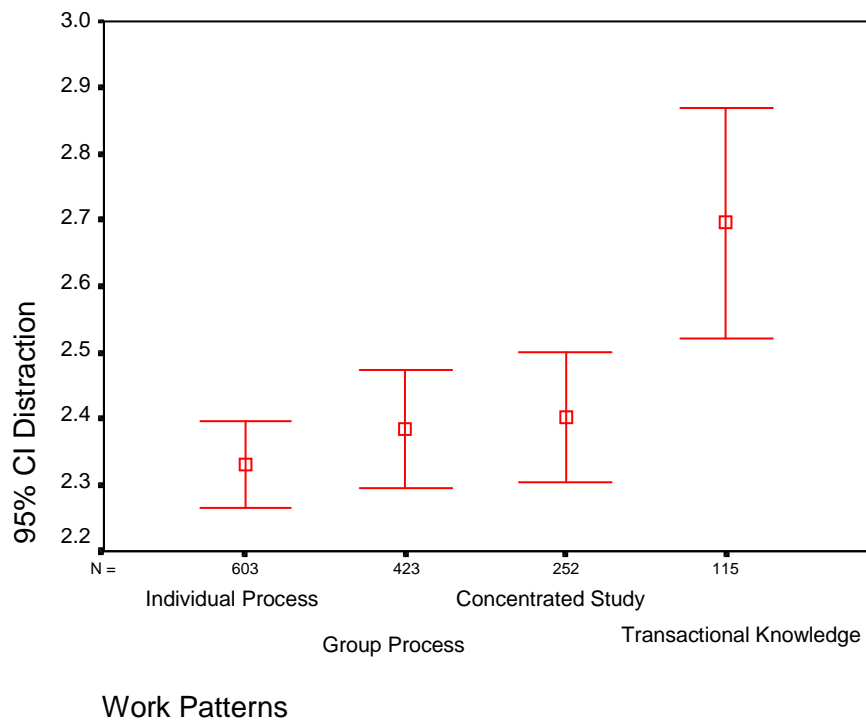


Figure 4 Error bars for distraction and work patterns

The results in Figure 4 graphically demonstrate the range of confidence intervals for distraction and work patterns. Clearly, as in the previous components, transactional knowledge workers have the most positive mean score and the largest confidence interval. In contrast the individual process workers have the most negative mean score and the smallest confidence interval. In contrast to the findings of Olson (2002), this study measures the component distraction using a multi-item scale; in addition this study provides a breakdown of analysis by work pattern type (Laing *et al*, 1998). It can be seen in Figure 4 that all categories of work patterns reported distraction in the office environment to be having a negative effect on their productivity.

Table:8 95% Confidence interval results for distraction and work patterns

		N	Mean	95% C.I. of Mean	
				Lower Bound	Upper Bound
Distraction	Individual Process Work	603	2.33	2.26	2.40
	Group Process Work	423	2.38	2.30	2.47
	Concentrated Study Work	252	2.40	2.31	2.50
	Transactional Knowledge Work*	115	2.70	2.52	2.87
	Total	1393	2.39	2.34	2.44

As can be seen in Table 8 a highly significant difference exists between the transactional knowledge workers and the other work pattern categories (individual process work = 2.33, group process work = 2.38, concentrated study = 2.4, transactional knowledge work = 2.7 $p < 0.01$). The group that report office layout to be having the most negative effect on their productivity are the individual process workers.

Whilst all categories report a negative result, the transactional knowledge worker reports the least negative. This could be because, as established previously, the transactional knowledge worker has the flexibility to work in different parts of the office and is therefore not restricted to a particular desk. Olson (2002) identified that on average people spend 35% of their time making noise near other people's desk. In addition, the nature of transactional knowledge work involves interaction, and therefore transactional knowledge workers could be more tolerant of distractions, such as interruptions. This is clearly a balancing act, as one person's interruption is another person's interaction (Heerwagen *et al*, 2004; Haynes 2007b)

Further analysis of the variety of tasks undertaken indicates a relationship between distraction and variety of tasks.

Table:9 Variety of tasks and work patterns

	Individual Process	Group Process	Concentrated Study	Transactional Knowledge
High - Very High Variety of Tasks	41%	47%	55%	76%
Mean Response	2.33	2.38	2.4	2.7

The results presented in Table 9 indicate that the more variety of tasks undertaken in the office environment, the less distractions are seen as having a negative effect on productivity. The extremes of the variety of task results support the NEW model (Laing *et al*, 1998) with the individual process workers undertaking mainly very low to average variety of tasks (60%), and transactional knowledge workers undertaking high to very high variety of tasks (76%). There appears to be evidence to support the proposal that workers that undertake high to very high variety of tasks in the office, whilst perceiving distractions to be negative, are less susceptible to distractions than office workers who undertake very low to average variety of tasks. The results indicate that productivity improvements could be achieved by the creation of a distraction free working environment (Mawson, 2002; Cornell, 2004; Haynes, 2007c).

1.4 Proposed Theoretical Framework

This research has attempted to evaluate how well the office environment supports the office occupier in their work processes. Underpinning this research is the proposition that office occupiers have “connectivity” with their office environment. This connectivity is both physical and behavioural and collectively can be termed “workplace connectivity”. It is proposed that the alignment of the

office environment (place) with the work processes provides increased workplace connectivity and productivity.

To develop this area of research further, it is suggested that there is a need for additional components to be included into a theoretical framework. A proposed theoretical framework can be seen in figure 5.

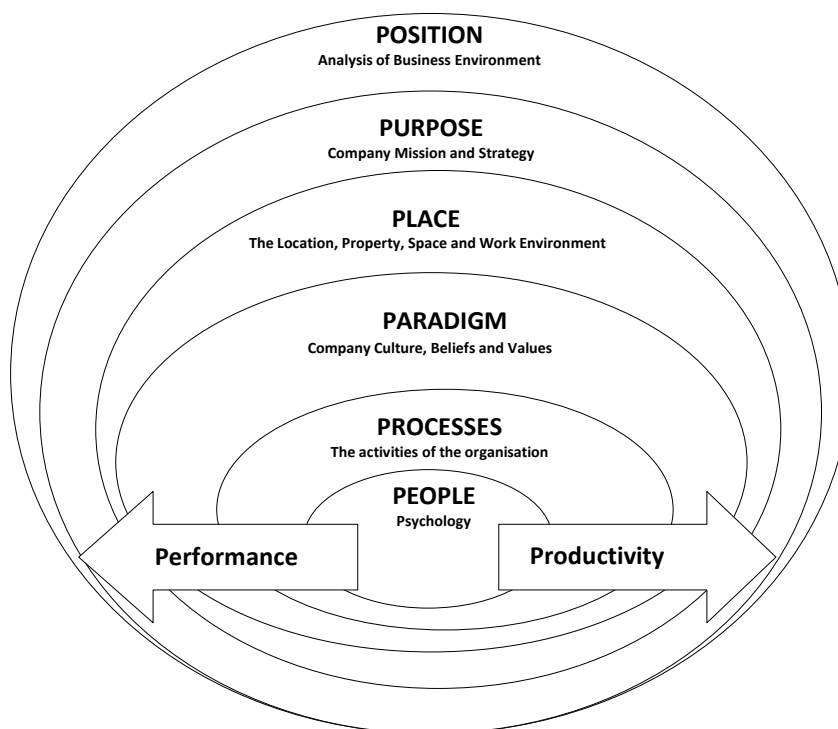


Figure 5 Real Estate Connectivity - The alignment model

It is proposed that a high performance and productive workplace can be created when position, purpose, place, paradigm, process and people are all in alignment. The 8 P's are as follows:

- Position - This component relates to the position of the organisation in the business environment relative to its competitors. In addition this component can also relate to the position of the organisation in the business cycle. An expanding organisation has different requirements to a restructuring or contracting organisation.
- Purpose - This relates to the business aims and objectives. This includes the company mission or vision statement and aims to establish the future direction of the business.

- Place - This has external and internal components. The external component relates to where the office building is physically located. The internal component relates to the building and office environment layout created.
- Paradigm - This relates to the organisational culture or "*organisational DNA*". It is important to establish how an organisation actually works and understand its beliefs and values. It is also important to establish micro cultures, the way that people actually work in the office environment; this could be considered to be the "*workplace DNA*".
- Processes - The activities of an organisation have a number of different levels. At one level this includes the interrelations between the different departments in an organisation, and at another level this relates to the specific work processes undertaken by the individuals in an office environment.
- People - Understanding the office environment from the occupier perspective is a central principle to the alignment model. This could be developed to include personality types and team role types.
- Productivity - This could include individual and team based productivity measures. Productivity measures maybe directly linked to business performance, self-assessed measures or a combination of the two.
- Performance - This could include the traditional efficiency measures of property and facilities performance, but would also include hybrid measures of business and property/ facilities performance. This could include revenue/m² or profit/m². In addition to evaluating "*effective space*" it is suggested that performance measures could be developed to measure "*affective space*". Since we experience office environments with all our senses, it seems appropriate to develop means of assessing how the office environment affects those senses.

Since human resources and real estate are usually the two main assets of an organisation, the proposed theoretical framework attempts to capture the need to achieve "*asset alignment*" leading to "*asset productivity*".

1.5 Conclusions

Whilst there are a number of components that can impact on office occupiers' productivity, this paper has specifically looked at the office occupiers' perspective of how well the office environment matches their work processes.

Results for the comfort component reported no significant difference between the concentrated study and the transactional knowledge workers. However, significant differences did exist between the process worker groupings, individual and group, and the knowledge worker groupings, individual and group. A possible explanation for this result could be that concentrated study and transactional knowledge workers have more flexibility in where they work, therefore they can exercise more control over their environmental comfort by

moving around the office (Whitley *et al*, 1995; Whitley *et al*, 1996; Haynes, 2008a). In contrast individual and group process workers are location required and therefore place a higher demand on the comfort systems (Laing *et al*, 1998).

The results for office layout indicate that only transactional knowledge workers perceive their office layout to be having a positive effect on their productivity. All the other work pattern categories perceive office layout to be having a negative impact on their productivity. This result on its own has a large implication, as it indicates that office environments are being designed without a detailed appreciation of the occupiers' proposed use of space (Peterson & Beard, 2004). An opportunity exists to ensure that office occupiers are consulted at all stages of the design process to ensure that the optimum office layout is achieved (Burke & Chidambaram, 1999; Laframboise *et al*, 2003; Haynes, 2008b).

All the work pattern categories reported a positive result for the component interaction, indicating its perceived value on productivity, although the transactional knowledge workers result was statistically significantly different from any of the other work pattern categories. This result illustrates the perceived value of interaction for transactional knowledge workers, supporting the proposition that "*knowledge exchange*" is a vital ingredient of the modern office. It should also be acknowledged that individual process workers, who are traditionally considered to be process production units (Laing *et al*, 1998), also perceive interaction as having a positive effect on their productivity. The interaction results clearly illustrate that the social dynamics of the office environment should be considered for all work patterns (Nathan & Doyle, 2002; Haynes 2007c).

All work pattern categories reported a negative result for the component of distraction (Olson, 2002; Mawson, 2002; Cornell, 2004; Haynes, 2007c). This result clearly indicates a common issue for all the work pattern categories. The transactional knowledge workers perceived distraction least negatively of all the other work pattern groups, which could be interpreted as indicating they are more tolerant of distractions. The results also indicated that the higher the varieties of tasks undertaken in the office, the least negative the results for distraction.

Overall, transactional knowledge workers reported more positive results than any of the other work pattern categories and were consistently a statistically significant different grouping from the other work patterns. Generally, there were no statistically significant differences in the results for individual process workers, group process workers and concentrated study workers for the components office layout, distraction and interaction. These results indicate, for these components, that the work patterns share the same view.

The two components that generally received consistent results were interaction and distraction. All the interaction results reported were positive, indicating a consensus across all the work pattern categories. Likewise all the distraction results reported were negative, indicating the consensus of opinion. These results indicate the perceived benefit of interaction in the office environment (Becker & Sims, 2001; Heerwagen *et al*, 2004; Haynes, 2007c) but also highlight the potential disadvantages of distraction (Olson, 2002; Mawson, 2002; Cornell, 2004; Haynes, 2007c).

Since space utilisation was not high, consideration needs to be given to more flexible shared areas as a way of reducing overall space requirement. If space can be reduced the cost savings can be reinvested into a higher quality office environment. Specific attention needs to be given to the quality, and control, of the comfort systems. To enhance interaction, whilst also ensuring minimum distraction, attention needs to be given to the office layout and the provision of common interactive areas and quite distraction free areas (Haynes, 2008b).

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ⁱ A fuller discussion of the measurement of office productivity can be found in Haynes (2007a)