CREM AND ACTIVITIES AT THE MODERN WORKPLACE

A STUDY OF THE VARIABLES INFLUENCING THE USE OF WORKPLACES IN AN ACTIVITY BASED OFFICE DESIGN

Key words: Corporate Real Estate Management, office design, Bayesian Belief Network,

Authors: Marleen Kleijn, Rianne Appel-Meulenbroek*, Astrid Kemperman, Els Hendriks

**contact author:*

Assistant professor Eindhoven University of Technology, The Netherlands
Chair of Real Estate Management and Development
mail: h.a.j.a.appel@tue.nl
tel: +31(0)40-247 2092

Purpose
Service oriented organizations have difficulties finding evidence based office design suited for new ways of working. This study provides CRE managers with information on factors that influence the activities at workplaces in an activity based office environment, and can be used for further development of office design.

Design/methodology/approach
Based on literature research a conceptual model is developed to show the relations between the workplace characteristics, physical environment, organization characteristics, user characteristics, and the use of activity based workplaces. Possible relationships are proposed based on the model.
Data is collected in 3 office environments in Belgium and the Netherlands, providing 90.890 observations of workplace usage. Specifically, a Bayesian belief network (BN) was used to derive and represent the causal relationships between all variables included. A major advantage of a BN is that the network structure takes direct and indirect relationships between the variables into account. The first network addresses the relationships between use of workplaces and CRE/organizational characteristics, without looking at user characteristics. The second network contains only data of occupied workplaces to study the influence of user characteristics. Both networks were used to test the model and predict the use of workplaces under (future) conditions.

Findings
According to the activity based philosophy, an employee chooses to perform his/her activity on the workplace that has the most suitable functional characteristics. Both networks, however, show more complex relations between the variables and expose relationships between environmental characteristics, workplace functionality and activity. The second network confirms that user characteristics influence the use of the workplace as well. It can be concluded that a CRE manager should develop at least two types of workspace to support the office activities in a service oriented organization.

INTRODUCTION

The way of working in a knowledge industry is subject to change. The past decade, several social, technological and economical developments can be distinguished, that influence the way people think about working (Haterd, 2010; Mooij, 2002).

Organisations become more aware of their ecological footprint and establish sustainable measures in their corporate strategy. This affects the way organisations value their premises and the Corporate Real Estate (CRE) strategy they pursue. Work processes have become more flexible and dynamic due to globalization and development of (online) communication systems and document management. Employees decide on their own working hours and more people have part-time jobs. As a result work is less place and time dependent (Van Meel, 2000; Van der Meer & Van 't Spijker, 2010).

The costs for CRE have grown over the years. Many CRE managers are faced with the challenge to reduce facility costs and creating a work environment that enhances employees' productivity and creativity (Brown, 2008). Organisations want to adjust the dynamic labour market and business processes, and look for more flexible, efficient and effective ways to deploy their real estate in business processes (Gibson, 2003; Inalhan, 2009). For these reasons many organisations create possibilities for 'New Ways of Working'. This management philosophy strives to increase productivity, commercial capacity and steers on financial management (Van der Meer & Van 't Spijker, 2010).

New ways of working, new generations and changing lifestyles require a new office concept (Duffy & Tanis, 1993; Van Meel & Vos, 2001). Many service organisations still use a traditional (cellular) office environment, which often lack in facilitating new ways of working (Becker & Steele, 1995). So, organisations have to look for better alignment between organization and CRE (Van der Voordt, 2003). Van der Voordt & Vos (2001) claim there is no unambiguous concept for the future office. Wrongful estimations of the required number and type of workplaces lead to office environments that do not support new work processes optimally (Duffy & Tanis, 1993). There is, however, few impartial and reliable information available with which CRE managers can test and justify design solutions and investments (Krumm & De Vries, 2003; Lindholm & Leväinen, 2006). Therefore, CRE managers have difficulties finding evidence based office design suited for new ways of working.

Insight in the way how employees are using and which variables influence the use of modern workplaces will contribute to the development of new office concepts. It is therefore useful to study which activities take place at which facilities, when these activities take place and which variables are of influence and document the spatial consequences (Van der Voordt & Vos, 2001). This paper provides CRE managers (of service oriented organizations) with such information. The first section describes activity based office design and assumptions for relevant factors. The next section proposes a conceptual model and describes the research method. The findings-sections relate the data to the conceptual model, followed by conclusions and recommendations for further research.

ACTIVITY BASED OFFICE DESIGN

Since CRE often is the second largest cost behind labour cost (Pole and Mackay, 2009), general management mostly measures the performance of CREM with financial input indicators. Luckily, the focus appears to be moving towards a cost/benefit ratio (Jensen, 2009; Nenonen, 2005), with 'benefit' as a broader term than just direct or indirect return on investments in real estate. Lindholm and

Leväinen (2006) identified 5 additional (non-financial) ways in which CREM can add value to the organization. Besides direct return ('Reducing costs') and indirect return (increase in the 'Value of assets'), these are 'Promoting marketing and sales', 'Increasing innovation', 'Increasing employee satisfaction', 'Increasing productivity' and 'Increasing flexibility'. In practice, the term 'increasing agility' is also used a lot.

With regard to added value, already in classic economic theory in the 19th century, a distinction was made between exchange and use value. With the former, the focus lies on cost (difference between output and input), so reducing cost by increasing efficiency leads to added exchange value. The latter focuses on the output: *"qualitatively different and improved output by increased effectiveness leads to added use value"* (Jensen, 2009). CREM can deliver added exchange value through 'Reducing costs', 'Increasing the Value of assets' and 'Increasing flexibility'. Added use value should be sought through 'Increasing agility', 'Increasing innovation', 'Increasing employee satisfaction', 'Increasing productivity', and 'Promoting marketing and sales'.

During the 1980s, the foundation for the activity based office concept came into being, called the CoCon-office (COmmunication andCONcentration). In the 1990s, the low occupancy rate of these types of offices brought about the sharing of workplaces (Appel-Meulenbroek, Groenen & Janssen, 2010).Thus the activity based office is a fairly new concept. The main idea behind New Ways of Working is to optimally support employees with a work environment that matches their needs during different activities. The concept has not yet been studied with regard to the types of added value. In practice, it appears as if the main motive for changing to this concept is exchange value. However, taking the idea behind it into mind, the added (or decreased!) use value should be worthy for a similar amount of attention.

In 2004 (Van der Voordt, 2004), about 10-15% of the Dutch organisations had adopted the management philosophy of the 'New Ways of Working'. This percentage has grown a lot since then, and this trend will probably set forward in the future. Figure 1 displays the most important core values of New Ways of Working according to Twynstra Gudde (Dutch consultants) (Van der Meer & Van 't Spijker, 2010). The term 'activity based office environment' is a widely used expression for different office concepts that have in common that all users, from employee till general management, can choose to work at all available workplaces and collective facilities, and where nobody is allowed to claim their own workplace (Keeris, 2001; Mooij, 2002; Veldhoen, 2005).

This type of office design consists of several types of workplaces, each facilitating a limited amount of similar office activities (eg Luchetti & Stone, 1985, Keeris, 2001, Mooij, 2002, Van der Voordt, 2004, Veldhoen, 2005). In the activity based office design, work activities can take place at all available facilities, not only workplaces, in the office environment. It is therefore better to speak of facilities rather than workplaces. Next, we will discuss expectations for relations in the conceptual model.

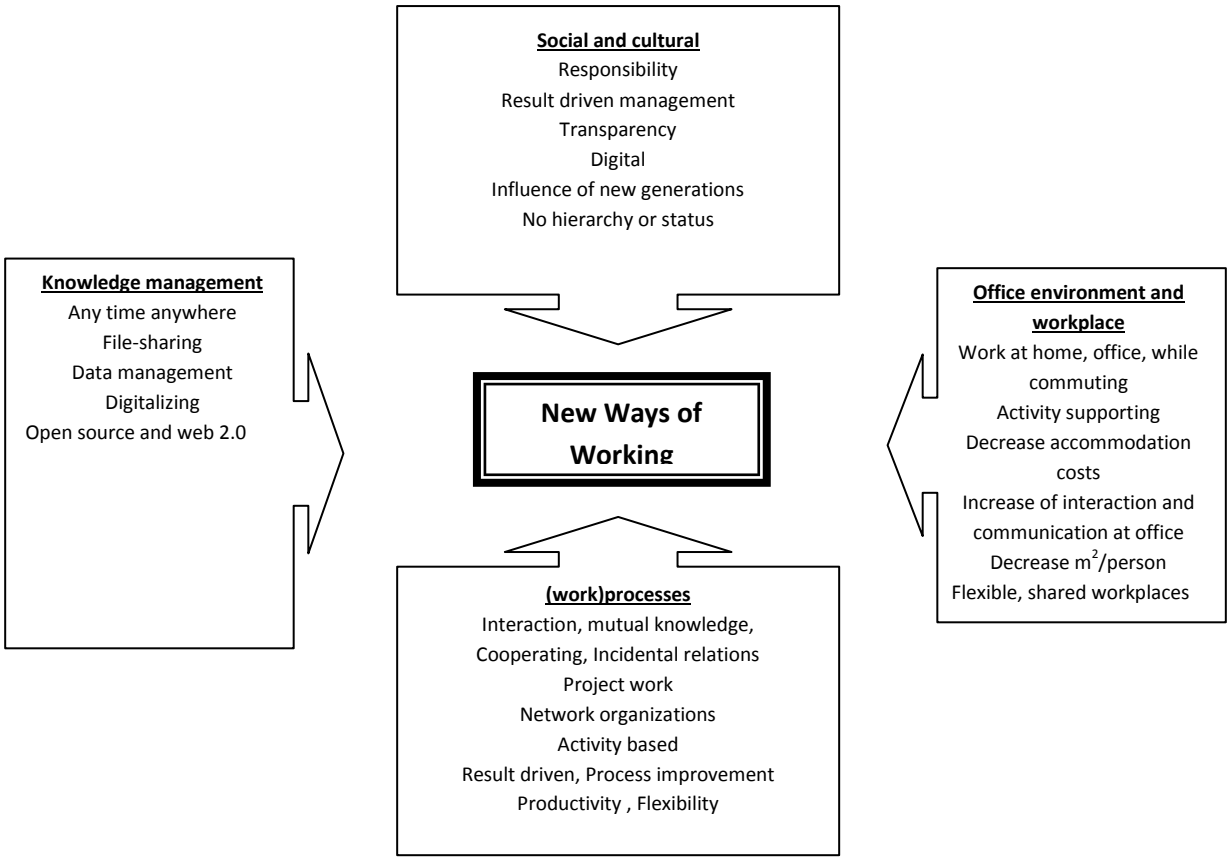

FIGURE 1: NEW WAYS OF WORKING ACCORDING TO TWYNSTRA GUDDE (VAN DER MEER & VAN 'T SPIJKER, 2010)

RELEVANT FACTORS

Table 1 shows a list of all the variables and factors. Several types of activities can be distinguished in service organizations (Van der Voordt & Vos, 2001) – for which number of users, workdays, formality level, concentration level, and required facilities can vary (Tabak, 2009; Mooij, 2002). The subject of this research is the type of activity that takes place at the workplace. The other characteristics of use in table 1 are expected to influence the type of activity.

Literature prefers the idea that the best location for conducting activities depends on the activity itself (Vischer, 1996; Becker & Steele, 1995; Gibson, 2003). For each activity it is necessary to find suitable dimensions (Gibson, 2003).The activity (use) conducted at a facility, according to this idea, depends on the characteristics of that facility. The form of use, capacity, type of facility, functionality and available facilities are therefore relevant for this study into the influence of functionality of the facility on its usage.

i. The activity based office design concept is based on the idea that an employee chooses the most appropriate facility for his activity. A relation is expected between activity type and functionality of the facility.

The environment of the facility, however, also determines the suitability of a facility for conducting an activity. Based on environmental psychology research, it can be stated that the choice of a facility is in part based on the environmental characteristics. The physical environment affects the way employees conduct their activities (Tabak, 2009). The degree of privacy, distraction factors, opportunities for interaction and appearance are the most important factors considered. The environmental

characteristics that make these factors measurable are the zone in which the facility is located, the openness of the space, the number of facilities in the area, the area size, the use of colours, and the use of materials.

The office and office design often are a direct measure of the standards and values within the company. Organizations may differ in various ways. The features included in this study are industry type, organizational culture, organizational structure and workplace sharing ratio.

ii. According to environmental psychology, the environmental characteristics and features of the facility are important factors in determining the suitability of a facility for certain activities. It is expected that the organisation has a major influence on these characteristics. Direct relationship between characteristics of use & environmental features / characteristics of the facility / organizational characteristics are therefore expected.

However, the characteristics and behaviour of the employees themselves seem to have the most influence on the use of facilities. In this research it is not the user's preferences, but the actual use of the facility that is the central subject of research. The preferences and behaviour of the user may however still affect the actual observed use (Appel-Meulenbroek, Groenen & Janssen, 2010). Hence the position, tenure, gender, age and cultural background of the user is included in the model

iii. The user ultimately decides which facility he considers best suited for an activity. Personal characteristics such as position or gender are therefore expected to have the strongest relations with usage variables.

TABLE 1 SUMMARY OF FACOTRS AND VARAIBLES OBTAINED FROM LITERATURE RESEARCH

Characteristics of use	**Facility characteristics**	**Office design characteristics**	**Organisation characteristics**	**User characteristics**
Type of activity	Form of use	Zone	Industry	Position
Number of users	Capacity	Openness of the space	Organisational structure	Tenure
Guests present	Type of facility	Number of facilities in area	Organisational culture	Gender
Demanded equipment	Available equipment	Area size	Workplace sharing ratio	Age
Workday	Functionality	Colour usage		
Time slot		Use of materials		

The relations discussed in literature, often describe the relationship between some of these factors. While it is recognized that the relations are expected to be much more complex, no model can be found in literature that jointly maps all possible influencing factors.

iv. It is expected that the use of a facility in an activity based office design is not a direct result of one characteristic, but a complex network of relations between the characteristics of the different factors.

v. It is also expected that the characteristics within a factor interact, thus increasing the complexity of the network.

CONCEPTUAL MODEL & RESEARCH APPROACH

Based on literature research a conceptual model is developed that shows the relations between the workplace characteristics, physical environment, organization characteristics, user characteristics, and the use of activity based workplaces. Figure 2 displays the conceptual model and has appointed a number to each possible relationship.

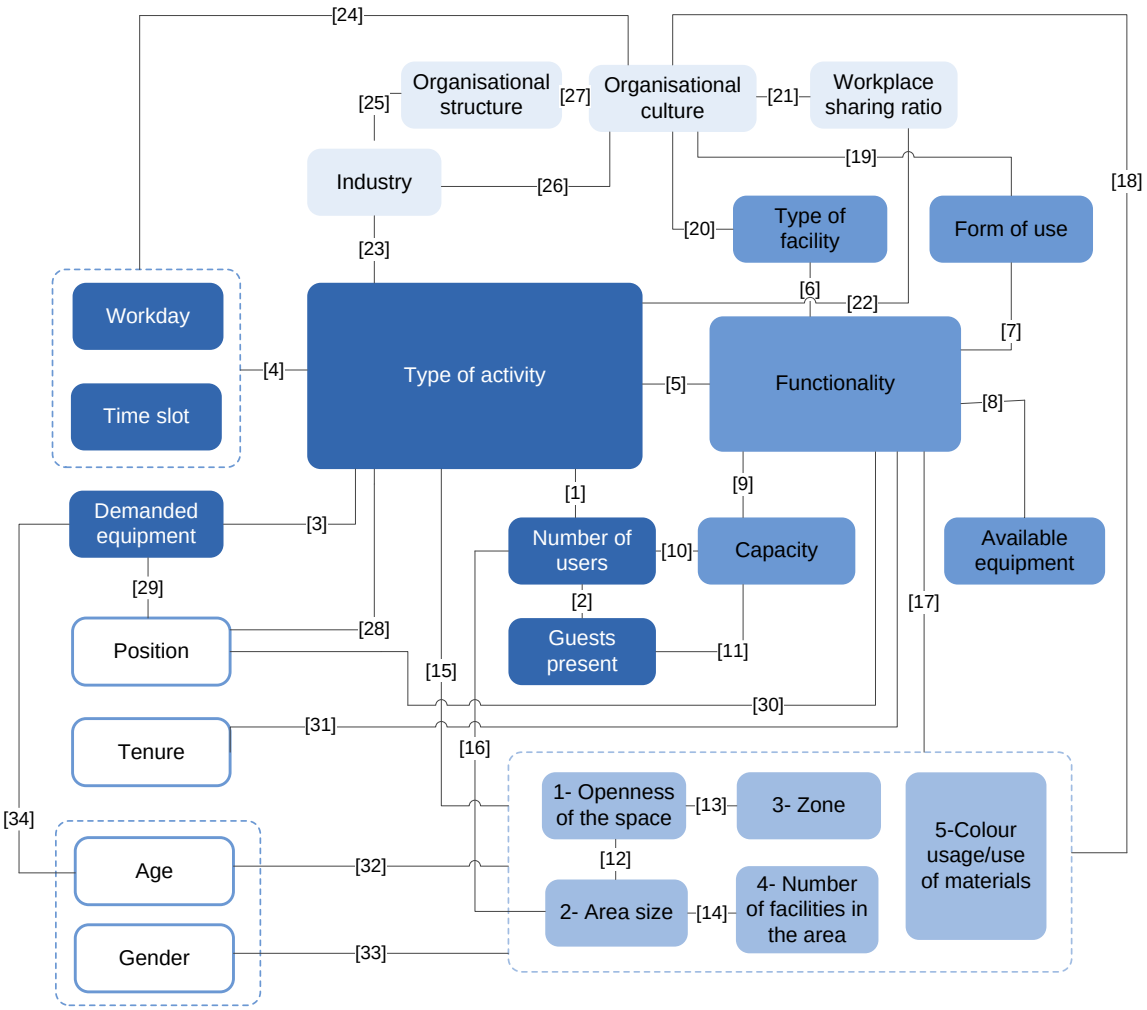

FIGURE 2 CONCEPTUAL MODEL, LITERATURE BASED (NUMBER = POSSIBLE RELATIONSHIP)

DATA COLLECTION

To test the conceptual model it is necessary to gather data on all variables. For a realistic impression of the use of modern workplaces, an observation method is most suitable for data collection (Runkel &McGrath, 1972). Wicely (www.wicely.com) obtained information by observations of facilities' usage. For this study, data was collected in 3 office environments in Belgium and the Netherlands that have adapted activity-based office design. Specifically, the usage of all facilities in the office environments is measured during all days of a normal working week. The usage of each facility is measured at least twelve times per day, except during lunch breaks. Facility usage is measured by the use of a computer system (ABOOT, developed by Wicely) including questions specified for each facility with pre-coded answer categories. This optimizes an efficient observation and reliability. In

total, 90,890 observations of facility usage were used for this study, showing a large variety in facilities and environments in which the facilities are located.

When the facility is "not in use" there is, of course, no data available on user characteristics. Therefore, the data set is analyzed in two ways. A first data set contains all the observations, excluding the characteristics of the user. And a second data set with the (smaller number of) observations of which the user characteristics are known. The first dataset is suitable to explore the relations between the factors which may affect the use of a specific type of facility. The second data set only contains observations of used facilities and takes into account the characteristics of the user. Both data sets are analysed with Bayesian Belief Networks.

BAYESIAN BELIEF NETWORK (BN)

A Bayesian belief network (BN) (Arentze & Timmermans, 2009; Heckerman, Mandani, & Wellman, 1995; Pearl, 1988) is used to derive and predict direct and indirect relations between all the selected variables. Formally, a BN is a directed acyclic graph in which the causal or temporal relations between the variables are represented by arrows. If there is an arrow from variable A to variable B, variable A is called the parent and variable B the child. For each variable a conditional probability table (CP table) is derived, which expresses the probabilities for that variable, conditioned on the values of its parent variables (if any).

In this study two networks are explored and evaluated. The first network '*the (un)occupied workplace*' addresses the relationships between use of workplaces and CRE/organizational characteristics; the second network '*workplace user*' contains only data of occupied workplaces to study the influence of user characteristics. In the *'(un)occupied workplace'* network the following variables were included: type activity, # of users, guests present, workday, time slot, type of facility, functionality, form of use, capacity, openness of the space, zone, area size, number of facilities, industry, workplace sharing ratio. The "*workplace user*' network takes the following variables into account as well: position, tenure, gender. Table 2 gives an overview of the variables per network. The categories of each variable can be found in appendix 1.

TABLE 2 VARIABLES IN THE NETWORKS

Network	Observations	Factor	Variables
The (un)occupied workplace	All observations	Use	type activity, # of users, guests present, workday, time slot
		Facility	type of facility, functionality, form of use, capacity
		Office design	openness of the space, zone, area size, number of facilities

		Organisation	industry, workplace sharing ratio
Workplace user	Observations 'in use' + user known	User	position, tenure, gender

The BN is a well-suited approach to address the research questions because it can handle discrete variables and variables such as type of facility, type of activity, organization type, and gender which are of a discrete nature. Another advantage of using a BN is that the effects of multiple variables on workplace facility use are simultaneously estimated. Finally, network-learning algorithms are used to derive (as opposed to estimating some assumed) structure of the network. Bayesian networks have been specifically developed to identify the structure of connections between variables.

Estimating a BN from data involves first learning the network structure and then estimating the conditional probability tables. BN-learning is based on the three-phase dependency method that develops the network based on tests of conditional independencies between pairs of variables (Cheng, Bell, & Liu, 2002). By setting a threshold the number of links in the network can be controlled: a lower threshold results in more links and a higher one in less links (Keuleers et al., 2001). In the second step, the conditional probability tables are estimated based on the same data set using the expectation-maximization (EM) learning algorithm (Lauritzen, 1995). PowerConstructor (Cheng, Bell & Liu , 2002) was used to learn the network structure and estimate the CP tables. The resulting network was visualized and compiled using Netica (Norsys Software Corp., 2006).

Once a BN has been constructed, it can be applied to a particular case. For example, the effect of changes in the type of activities and the use of workplace facilities can be predicted. For this purpose, the condition state of the variables is entered as evidence. Subsequently, probabilistic changes in the other variables can be predicted and thus the effects of changes in certain conditions can be simulated. Every time new evidence is entered into the network, the CP tables of all variables can be updated based on well-known Bayesian belief updating methods.

FINDINGS

Table 2 presents the variables that are included in the BN model. The threshold for establishing links between the variables was set at 2.0, indicating that only very strong relations between the variables are shown (the standard norm for the threshold is 1.0). The resulting networks *'(un)occupied workplace'* and *workplace user*' are presented in Figures 3 and 4. The bar diagrams show for each variable the probability distribution across the categories of the variable. The arrows represent causal relationships between two variables.

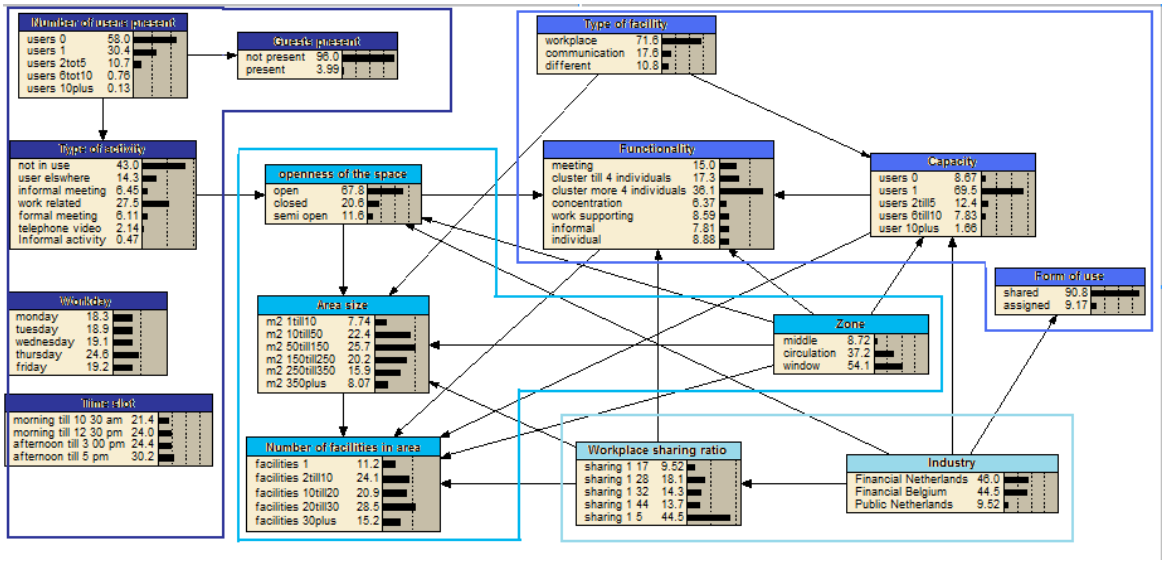

FIGURE.3 BAYESIAN NETWORK '(UN)OCCUPIED WORKPLACE

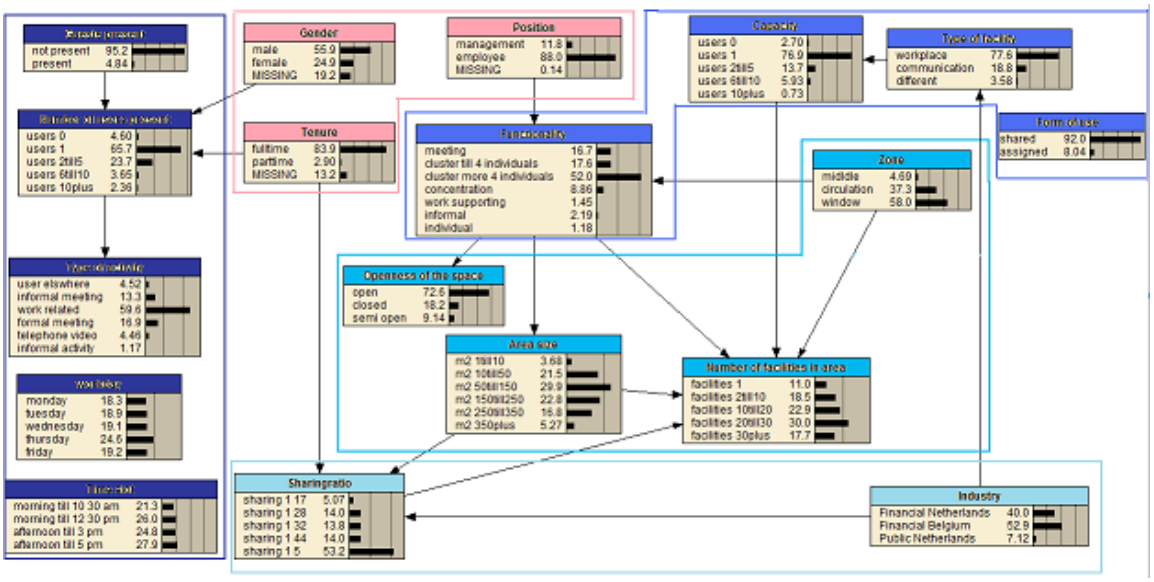

FIGURE 4 BAYESIAN NETWORK 'USER WORKPLACE'

As expected, the network of relations between the variables is complex. Yet fewer variables directly affect the use of the facility than initially expected. The expected relationships often do exist indirectly through other variables. This confirms the assumption that it is inaccurate to only consider the influence of one variable on the use of a facility. Some expected relations are not found in the networks, but on the other hand relationships emerged which were not expected, but are considered relevant for this research.

USE OF THE FACILITY

In the Bayesian network - "The (un) occupied workplace" the complexity of the relationships can clearly be observed. The only direct relationship that exists between the variables of 'use' of the facility and environmental variables occurs between type of activity and openness of the area. The variables which have an indirect relationship with the use of the facility are area size, number of facilities in the area and the functionality of the facility. The unoccupied facilities are more likely than

average to be meeting facilities, informal facilities and individual workplaces. All these facilities are mainly situated in closed spaces. It is not remarkable that facilities in enclosed spaces are often vacant. This may be related to over dimensioning of these facilities to accommodate ‘rush-hour’, and to the fact that they are designed for use during short periods by consecutive users. The cause may, however, also lie in the closed nature of the space or the possibility to reserve the space.

Different degrees of openness of space provoke different type of activities. In open spaces, a user is often elsewhere. Informal meetings, work-related activities and telephone activities mainly take place in open spaces. So, it can be said that regular work activities mainly take place at facilities in open spaces. In a regular accommodation concept (cellular offices), a short conversation with a colleague, conversations in a cluster and a phone call to a colleague are activities that take place at the individual workplace. As the cluster facilities are located in the open spaces, these mainly used for these regular activities. However, it must be noted that the data used in this research provided mainly cluster facilities in the open spaces. The enclosed spaces contain predominantly individual and meeting facilities. Learning from environmental psychology, meetings and concentration activities are better performed in closed spaces, so that colleagues can not disturb or be disturbed.

For certain types of activities employees seek an environment that meets the required concentration and communication conditions. The concentration level of activity is not included in this study. It turns out that closed spaces indeed are predominantly used for meetings, phone / video activities and informal activities. Whether this is the result of the closed nature of the environment or the functionality of the facility cannot be confirmed. Looking at the network, it appears to be a result of the joint effect of the two variables. Semi-open spaces are more often used for meetings than for informal meetings, which they initially are intended for.

In the activity based office design, informal facilities such as seating areas and lunchrooms are provided to facilitate informal meetings. But findings show informal meetings taking place at cluster facilities just as much than at these work supporting facilities or informal facilities. This is probably so, because informal meetings often happen spontaneously within the cluster. A move to a semi-open, informal facility can suppress spontaneity. It also appears that groups (> 2 persons) more than average make use of work supporting facilities (printer, library), and less than average of informal facilities (waiting room, coffee corner). Often these work supporting facilities are situated in the neighbourhood of coffee machines. This is a place where employees meet coincidentally. Users of clusters leave their desk more often than on average, because clusters are positioned in open areas, where employees feel freer to come and go than in a meeting room.

A separation can be made between the use of the facility and the area size of the surrounding area. There is a relation found between smaller spaces (with an area between 1 and 50 m2), type of activity, the facilities and the number of users. Areas of 1-50 m2 are most often used by groups of employees which have a meeting and these areas are also unoccupied most, which is normal for meeting rooms. In contrast, larger spaces, particularly areas of 50-150m2, are mostly used by individual employees engaged in regular work activities. Most of the open spaces are 50 to 150 m2 and are used for the regular work activities. When the area size of the environment increases, it is a logical consequence that the number of facilities in the space increases, but also here a separation can be made. Spaces with 2-10 facilities are used for meetings and informal activities and areas with 20-30 facilities are often used for informal meetings, work-related activities and telephone activities.

FUNCTIONALITY AND FACILITY

The network shows that type of facility, capacity and functionality are (indirectly) related with each other. These characteristics belong to the same factor, and appear to indeed affect each other. Because the number of users has an impact on the type of activity, and thereby on the openness of the environment and functionality of the facility, an indirect relationship exists between number of users and functionality. The number of users determines (indirectly) which facility is used, but the suitability of the facility for the number of users depends mainly on its capacity. It is logical that a facility with a capacity of 6 persons is not used by a group of 20 persons, but whether a facility with greater capacity is used by smaller groups could not be detected in this network.

Interestingly, the form of use of the facility has no direct relation with the rest of the variables within the factor facility. It is only influenced by the industry in which the organization operates. In this research, case studies are considered within three industries, each with an applied activity-based office design concept. The Dutch public sector differs significantly from average when looking at facilities that are shared, as still over 28% of the work facilities is assigned to certain employees, while this percentage in the financial industry is much lower. The difference might be caused by the lack of trust in new work concepts within the public industry. The financial industry is much more familiar with new concepts than the public industry. The first activity related accommodation concepts were introduced within financial institutions. The public sector started to focus more recently on the strategic use of property. Another explanation could be that a large amount of public employees have work methods and ICT instruments that are inappropriate for activity related environments. However, it is also possible that the cases which have been used in the study are not representative of the entire population. Similar organizations should be studied to see if similar results occur.

FUNCTIONALITY AND ENVIRONMENT

Looking at the environmental characteristics in the network it is notable that the area zone affects all other environmental characteristics and also has a relation with the functionality and capacity of the facility. In the middle zone, most of the facilities can be found. This is logical since the middle of a floor has the largest area. It mainly contains small clusters, but also well above average meeting facilities, concentration spots, informal facilities and individual workplaces. The circulation area contains, above average, cluster facilities and work and support facilities. In the window zone many meeting facilities and clusters can be found. It is logical that the probability of the presence of clusters is high, because this type of facility is used a lot in activity based concepts. This is mainly because they are suitable for a variety of activities. As noted before, some of the relations simply exist due to the existing data in the dataset.

There is no relation between size and functionality observed in the network. This is probably caused by dividing different types of facilities with different functionality, into various categories of area sizes. The industry will affect the capacity of the facilities, form of use, openness of the space and the sharing ratio. Many of the relations found are explained by the organizational management of the design features of the facility and surroundings.

USER WORKPLACE

Looking at the network ‘user workplace’, it is visible that when user attributes are included in the model, relationships develop between gender, tenure, number of users present and use of the facility.

Changes in the CPT of variables from the environmental characteristics, organizational characteristics and facility characteristics have no or very little influence on the conditional probabilities in the variables of the characteristics of ‘use’. Except for the characteristic position of the user, user variables have no influence on the functionality or environmental characteristics.
Key relation between user characteristics and characteristics of use are those between gender – number of users present - type of activity and tenure.

It can be concluded that gender poses virtually no difference in use of the facility. The conditional probabilities differ little from each other, and from the average. One explanation is that positions within the cases studied, are evenly distributed among men and women and that they perform similar activities. There is a clear difference between part-timers and full timers. They both predominantly perform work-related activities, but part-timers have informal and formal meeting more often than on average. One possible explanation is that part-timers must be briefed more often on progress at work while they were absent.
There is also a relation between function and functionality of the facility. In practice it often happens that executive management puts up some resistance to planned changes in the workplace. They claim that their function is not suitable for the activity-related concept and their activity profile show that this is true. The use of facilities by executive management in these 3 cases indeed differs from that of a regular employee. The managers mainly used closed meeting facilities and use concentration facilities more often than on average, while staff uses concentration facilities just slightly less than average. Missing values in the data for the variable ‘position’ are `present mostly for observations in meeting facilities. A logical explanation is that during the observations it has been unclear to the observer exactly which employees were present in the meeting room.

CONCLUSIONS AND RECOMMENDATIONS

According to the activity based philosophy, an employee performs an activity at the workplace that has the most suitable functional characteristics. Both networks, however, show more complex relations between the variables and expose relationships between environmental characteristics, workplace functionality and activity. The second network confirms that user characteristics influence use of the workplace as well. Based on the results of the Bayesian network - "The (un) occupied facility", it can be concluded that for certain categories of activities there are clear similarities in used environment and facilities. The categories of activities are divided into two groups, group activities and regular work activities. The concentration factor is not included in this study, so no statements can be made about the possible distinctive spatial features for activities that require concentration.

From the results could be concluded that a CRE manager should realize at least two types of spaces to support all activities within the service organization. Firstly, areas are necessary to perform regular work activities by individuals or small groups (2-5) persons. These spaces contain > 10 facilities, measure 50-350 m^2 and are open. In addition, rooms are necessary where meetings and informal group activities can take place. The group size is > 2 users, but these rooms are used mostly by groups over six users. These spaces are closed or semi-open, contain 1-10 facilities and measure 1-50m^2. The comment must be added, that this is not a plea for large meeting rooms. Practice shows that small meeting facilities, that support individual work and small informal/formal meetings, are appreciated more.

The introduction of 2 types of environments will probably not optimally support all activities. For example, individual concentration facilities are not specifically provided this way. But at the same

time, it does seem efficient to provide universal environments in which almost all activities can be performed, because most real estate managers face financial and spatial challenges. Perhaps CRE managers that have chosen to focus on added exchange value might be best of with only two types of work environments, while the ones focusing on added use value should choose for more diversity.

From the Bayesian network -"The user workplace" it can be concluded that the personal characteristics of the user have a major influence on the activity being performed. In office design it is therefore very important that the CRE manager takes the wishes of individuals into account. However, the personal characteristics of employees of an organization are always subject to change. Creating an environment as variable as possible, consistent with what groups of employees needs, is a more realistic solution. This study provides a first step towards more insight in this, but further research into the relationship between personal characteristics and use of facilities as well as research on segmentation of users is necessary.

In conclusion, the main influencing variables on which activities within certain facilities and environments will be performed (based on this research) are the number of users, the openness of the environment, the functionality of the facility, the area size and the number of facilities in the area.
A striking result is that many work-related activities take place at cluster facilities, even though it is also possible to choose for individual sized facilities in enclosed areas with better concentration opportunities. Only activities where a lot of concentration is required and activities that might disturb others at their work, will probably take place in a different environment. In this study, however, it was not possible to distinguish between normal activities and concentration requiring activities. For a better dimensioning of required facilities this subject requires further research.
Also, the choice of the user is not included in this study. The results in this study are based on observed use and therefore may not be representative for desired use. Based on this research it cannot be concluded whether the user has chosen the facility for its characteristics or because the facility of his choice did not exist, was not near or was already occupied.

Other recommendations for further research include:

- Combining consultants or promoting observations by end-users themselves to obtain larger datasets, so that sector differences can be studied,
- Gathering data on factors in the conceptual model, that we did not have data on, e.g. the influence of organisational culture and employee generations,
- Including the time between implementation of the office concept and the data gathering, as it takes time for employees to get used to their new environment.

This paper is an example of how CREM can get a better grip on how to add value with activity based office concepts. Each CREM department will have to look within their own 'black box' and see how the concept is best implemented to support the goals of their client organisation. Also, only through synergy with other strategic resources (business units) of an organisation, it is possible for CREM to add both exchange and use value and aim for strategies based on effectiveness of the organisation.

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APPENDIX 1

Variable	Answer categories
	Chracteristics of use
Type of activity	1. Not in use 2. User elswhere 3. Informal meeting 4. Work related activity 5. Formal meeting 6. Telephone/video 7. Informal activity (coffee/copying)
Workday	1. Monday 2. Tuesday 3. Wednesday 4. Thursday 5. Friday
Time slot	1. 8:30-10:30 am 2. 10:30-12:30 am 3. 1:30-3:00 pm 4. 3:00-5:00 pm
Number of users present	1. 0 users 2. 1 user 3. 2-5 users 4. 6-10 users 5. >10 users
Guests present	0. Not present 1. Present
	Facility characteristics
Type of facility	1. Workplace 2. Communication 3. Different
Functionality	1. Meeting facility 2. Cluster <4 individuals 3. Cluster >4 individuals 4. concentration 5. work supporting 6. Informal facility 7. Individual workplace
Capacity	1. 0 users 2. 1 user 3. 2-5 users 4. 6-10 users 5. >10 users
Form of use	1. Shared 2. Assigned

Office design characteristics	
Area size	1. 1-10 m2 2. 10-50m2 3. 50-150m2 4. 150-250 m2 5. 250-350 m2 6. >350 m2
Number of facilities in area	1. 1 facility 2. 2-10 facilities 3. 10-20 facilities 4. 20-30 facilities 5. >30 facilities
Zone	1. Middle 2. Circulation 3. Window
Openness of the space	1. Open 2. closed 3. Semi-open
Organisation characteristics	
Industry	1. Financial Netherlands 2. Financial Belgium 3. Public Netherlands
Workplace sharing ratio	1. 1.17 user/workplace 2. 1.28 user/workplace 3. 1,32 user/workplace 4. 1,44 user/workplace 5. 1,5 user/workplace
User characteristics	
Position	1. Management 2. Employee
Tenure	1. Fulltime 2. Parttime
Gender	1. Male 2. Female