Layout mechanisms that stimulate innovative behaviour of employees

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ABSTRACT

If an organisation aims at stimulating organisational learning and innovation, FM should align by stimulating innovative behaviour like knowledge sharing. Encouraging employee innovation is the most important FM strategy focusing more on effectiveness of the organisation, besides the general focus on efficiency through reducing costs. But the added value of the workplace for innovation remains hard to be proven empirically. To be able to show added value it is necessary to have suitable quantitative metrics, and discover the underlying mechanisms for evaluating office design, like stressed in Realistic Evaluation theory. This paper describes statistical tests on an R&D based organisation of three different layout mechanisms. We used eight quantitative layout metrics and several knowledge sharing behaviour metrics (obtained with logbooks from 138 employees) to show how added value is achieved.
The strong influence of context on the working of the mechanisms makes it hard to generalise results to other organisations. But the findings did prove that different layout mechanisms exist, and that realistic evaluation and the quantitative layout metrics that were distinguished are a valid way to study them inside an organisation. They help FM prove how it is adding value to the organisation. Projecting the results from the case-study on the new layout gave insight in the knowledge sharing that should take place after a planned renovation program would be implemented. This helped the FM to discuss his plans with general management and other stakeholders in his organisation.

Keywords

Innovative behaviour, Layout mechanisms, Added value, Workplace

1 INTRODUCTION

Before, Facility Management (FM) decisions were made with no overall strategy in mind or coordination with other units (Gibler, Black and Moon, 2002). But this is changing, as real estate is getting more attention from general management. Because Corporate real estate (CRE) is a costly resource, they often benchmark it with financial input indicators only. But FM can add value to the organisation with CRE in more ways (Lindholm and Leväinen, 2006), which can be grouped in:

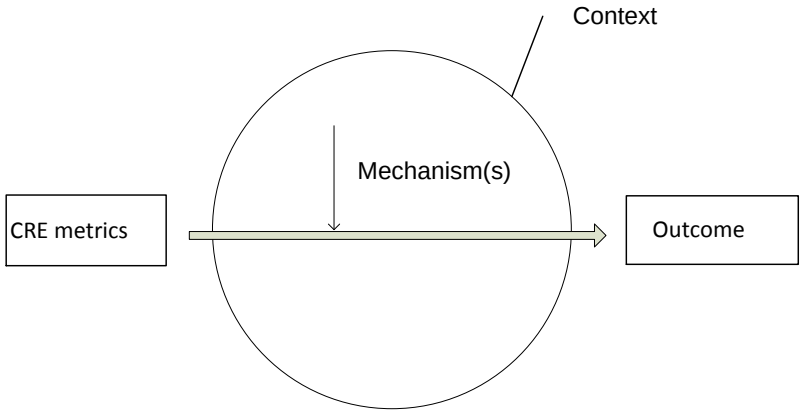
- Added exchange value ('Reducing costs', 'Increasing the Value of assets', 'Increasing flexibility').
- Added use value ('Promoting marketing and sales', 'Increasing innovation', 'Increasing employee satisfaction', 'Increasing productivity').

While exchange value lies fully within the expertise field of FM, tuning with other business functions is necessary to deliver use value (e.g. HRM, R&D, marketing). To be able to coordinate with other business functions, FM needs to be at the strategic table, which is too often not the case.

A focus on unit costs and building condition rather than overall costs and effectiveness will keep FM from capturing full strategic attention (Price, Ellison and MacDonald 2009). But to prove added value it needs reliable techniques for (pre-occupancy) evaluations of designs or buildings. Evaluation delivers the power to justify decisions to general management. Realistic Evaluation is a theory developed by Pawson and Tilley (1997) that tries to perfect methods of evaluation. It tries to identify mechanisms behind the working of programs (see Figure i). To do that, quantitative metrics of CRE are necessary, to prove correlation with organisational outcome metrics.

In the modern world, innovation is key. Although innovation is getting a lot of attention, the working of the mechanisms underlying the added value of CRE for innovation outcome is not clear (Steen and Markhede, 2010). Our literature study did suggest, however, that specifically building design can stimulate innovative behaviour. Especially knowledge sharing behaviour is important for innovative strength of organisations, and thus the focus of this study. The effect of building form and layout on behaviour is hard to measure because they are mostly described with qualitative aspects. With these, FM cannot prove the success of the design to general management. Therefore, the goal of this exploratory research was to develop and test a list of suitable quantitative metrics that can prove through which mechanism(s) layout adds value to knowledge sharing behaviour within a specific context and organisation. This provides FM with a tool to identify possibilities for increased added value within their own organisational context. After a review of existing literature, and development of a conceptual model, the research approach is described. This is followed by our findings, discussion and recommendations.

Figure i Causation according to Realistic Evaluation.



2 LITERATURE REVIEW

2.1 Knowledge sharing behaviour

Knowledge sharing (KS) is defined as *"the application of knowledge for the benefit of oneself or another person in interaction"* (Berends, 2003). There is a common distinction in most knowledge management literature between explicit knowledge (information) and tacit knowledge (experiences, skills, attitude). Our definition complies with the practice-based perspective, which stresses the embeddedness of knowledge in purposeful human activity (Hislop, 2009). It also emphasizes that ICT cannot replace the necessary face-to-face communication for tacit KS (Nenonen, 2005), but can only be used to share explicit knowledge.

Many synonyms are used for KS, like collaboration, communication, and integration. But in general, a distinction is made between (brief) interactions and more time-consuming and interdependent collaboration (Kahn, 1996). Most (objectivist) research focuses on the first level, because it is a behaviour that is relatively easy to quantify, measure, and change by management (planned meetings, document exchange). Collaboration has the same interactive behaviour but with more interdependence and combines this with attitudinal aspects, which are harder to measure (they are inside the human mind). Stimulating collaboration therefore remains more of a lacuna. But as it has a more positive influence on innovation than interaction (Kahn, 1996), it deserves more attention.

The tacit and explicit knowledge components are not totally inseparable. Similarly, the line between interaction behaviour and collaboration behaviour is not very clear either, because the same communication channels and activities can be used. The difference lies more in the wilfulness of actually wanting to achieve something together (involvement) versus just exchanging information. Interaction and collaboration can be operationalised with categories of KS moves identified through observing researchers in different organisations (Berends, 2003). These moves might also determine the (type of) knowledge that can be shared, based on the involvement during the cooperation between persons. While interactions have been shown to help in sharing explicit knowledge, it is assumed that this might not be enough to share tacit knowledge. Interaction activities are giving descriptions and reporting on explicit information in either an oral or written form. For more tacit KS collaboration it is deemed necessary, to share knowledge through activities involving proposals, evaluations, questions and engaged actions.

2.2 Layout mechanisms

The literature proving a positive influence of layout on any synonym of KS, has been interpreted in a content analysis to identify in more detail the layout mechanisms that might increase interaction and/or collaboration (see Table 1). One local workplace mechanism came forward that stimulates both interaction and collaboration:

- Visual/aural accessibility. Working in visually open layouts enhances face-to-face interaction through seeing and overhearing. If people can see others at their workstations, they can collaborate, share tasks and ideas more easily and provide assistance, because they are more aware of other people's need for help.

For the building as a whole, two mechanisms could be identified of which only the first one has been shown to influence both interaction and collaboration:

- Centrality. Spaces that are centrally located and have connections to many other places enhance unplanned interaction because of their connection to well-trafficked pathways. Also it is easier (faster) to walk over to colleagues to share knowledge.
- Exposure. Layout controls the flows of people on a floor and who get to know each other. Because of exposure, employees sitting close to the flows of movement interact more.

Table 1 Literature on layout mechanisms

Mechanisms / **Sources**	**Accessibility**		**Centrality**		**Exposure**	
	Inter-action	**Collabo-ration**	**Inter-action**	**Collabo-ration**	**Inter-action**	**Collabo-ration**
Allen, 1977	X					
Grajewski, 1992			X			
Becker, Quinn and Tennessen, 1995	X	X	X			
Covi, Olson and Rocco, 1998	X	X				
Spiliopoulou and Penn, 1999	X		X			
Penn, Desyllas and Vaughan, 1999	X		X	X	X	
Becker and Sims, 2001	X	X				
Rashid *et al*., 2006			X			
Markhede and Steen, 2006			X			
Markhede and Koch, 2007	X					
Wineman and Adhya, 2007			X			
Sailer *et al*., 2007	X	X	X	X		
Brown, 2008			X			
Toker and Gray, 2008			X		X	
Blakstad, Hatling and Bygdås, 2009	X	X				
Steen and Markhede, 2010			no		X	
Koch and Steen, 2012	X				X	

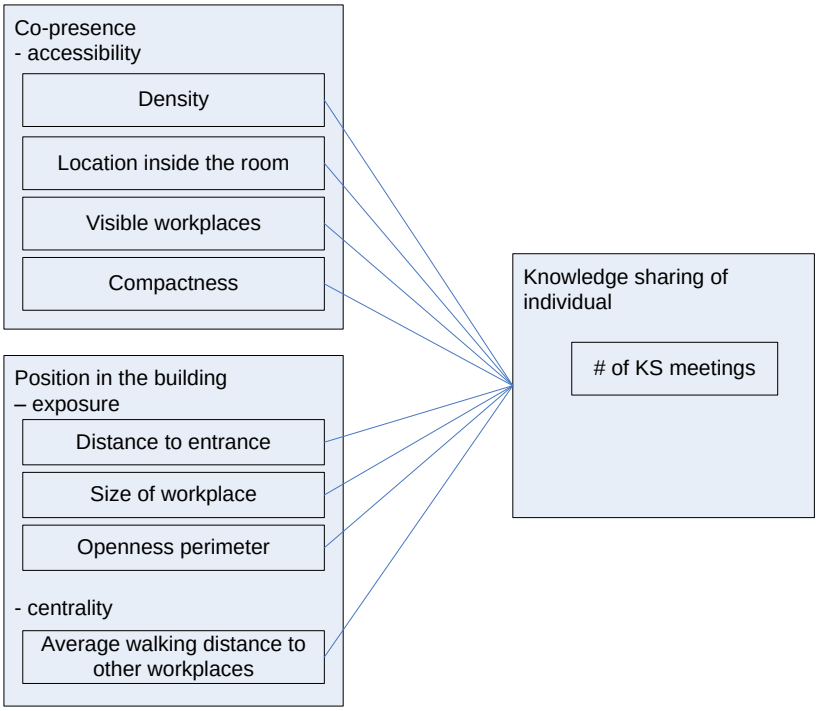
If there is one thing that these layout studies point out, it is that people are more inclined to cooperate when they see each other, whether it is for a long(er) time or when passing by. Others have referred to this as 'spatial behaviour', and distinguished between Co-presence (number of active and/or inactive people visible) and Movement (number of people moving along a path) from a building/spaces point of view (Steen and Markhede, 2010). Co-presence is the more local spatial behaviour. The positive influence of visual/aural accessibility can be assigned to this spatial behaviour. Exposure and centrality within the building relate to the global spatial behaviour called movement. As in this paper the unit of analyses are the employees of an organisation and not the spaces itself, movement was renamed into Position in the building, which regards the movement nearby.

Previous studies that identified mechanisms have several shortcomings in their methodologies, and do not compare the strength of all the mechanisms. For data on KS, they often use perceived data from surveys, and/or only communication without taking into account the content of what is shared. The data collected on the layout, are hard to extend to buildings in general, because they only studied certain types of spaces or used longitudinal studies without quantifying the design. It is important, that metrics cannot only describe the layout quantitatively, but are also close to an

intuitive understanding of space. Otherwise, non-real estate people, what general management usually is, will not understand it.

Therefore, for this study eight such quantitative layout metrics were identified to study the effect of all three mechanisms on the number of KS meetings of individuals (see the conceptual model in figure ii). Next, the association of the metrics with several other descriptors of KS were studied to get more insight in what has happened during the meeting and to distinguish between interaction and collaboration.

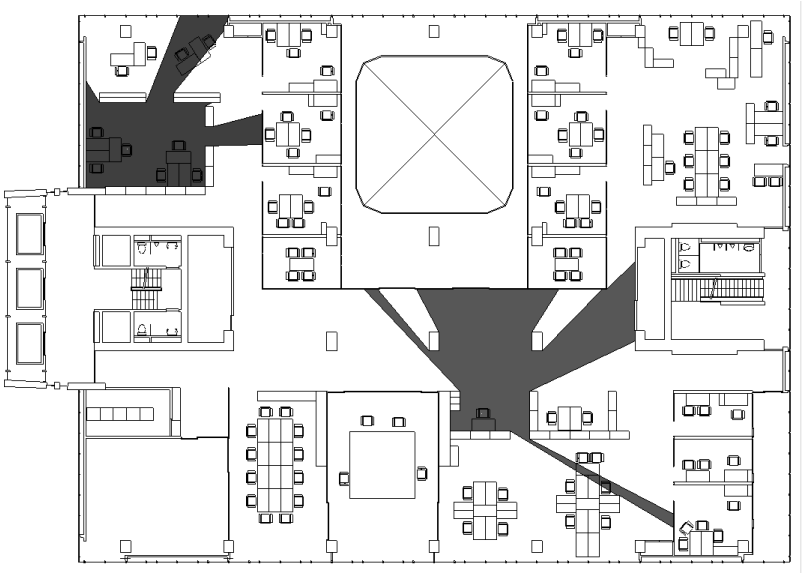
Figure ii Conceptual model.



3 RESEARCH APPROACH

To obtain the layout metrics, isovist and visibility graph analyses were used. An isovist is defined as "*the set of all points visible from a given vantage point in space and with respect to an environment*" (Benedikt, 1979) (see Figure iii). When isovists are placed on a regular grid, a visibility graph can be derived, which is a "*graph of mutually visible locations in a spatial layout*" (Turner et al., 2001) (see Figure iv). Isovists are useful because they describe the exact layout area that supplies visual accessibility (co-presence). Visibility graphs describe the layout of the floor as a whole from the viewpoint of exposure and centrality. Each node can be seen as a potential place for another person. Depthmap software (version 7.12) was used, because it could generate all metrics, and read AutoCAD drawings.

Figure iii Example of isovists at eye-level from 2 different workplaces.



To collect the behavioural data, a logbook was chosen, because it outperforms a questionnaire in validity, and sample surveys in precision of measurement. Besides personal information (e.g. days present at work, location of desk), participants had to fill in date, start time, duration, location and conversation partners for all face-to-face meetings during which work related issues came up. As planned meetings are less likely to be a result of the physical work environment as unscheduled conversations, the intentionality of each conversation was asked as well, to filter out the scheduled meetings. It also contained questions on the KS activities, the initiator and the issues addressed. Last, questions on the presence of an alternative source to acquire the shared knowledge, and involvement of the other person were taken up, to test assumptions on tacit and explicit knowledge and differences between interaction and collaboration. A test of the logbook showed that the KS items chosen to study the KS process in more depth were clear to its users, and that there were no major problems filling in the logbook.

4 RESULTS

The R&D building of an industrial research organisation (Océ Technologies) was chosen as the subject of this explorative study. It was built in 1984 and in need of a renovation. In total 269 employees had a workplace in the building, of which 138 kept a logbook during one week (51% response rate). This provided us with a database of 1907 KS meetings. The building has two floors (see Figure v), and has both large and small rooms, ranging from single-person rooms to open areas with up to 29 workplaces. Small lab areas without daylight are concentrated around the corridors.

Figure iv A visibility graph example.

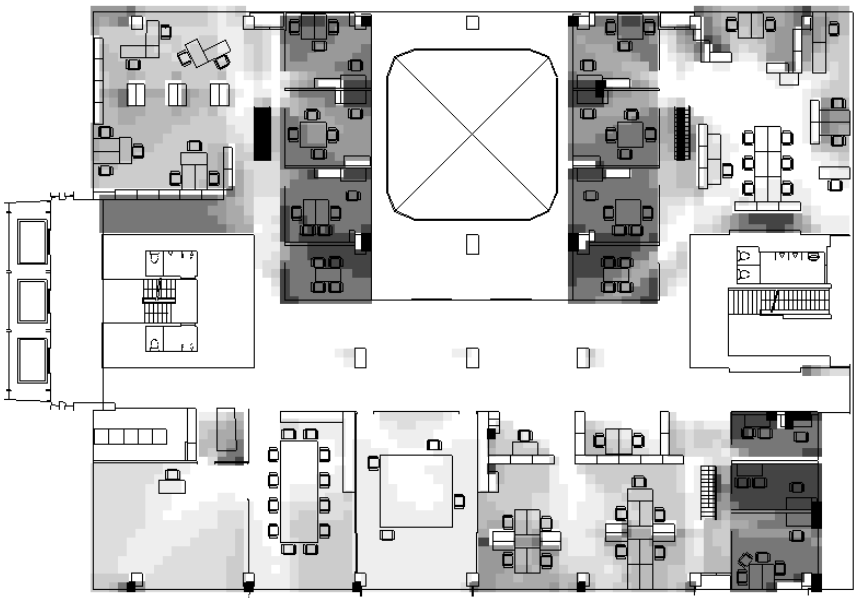
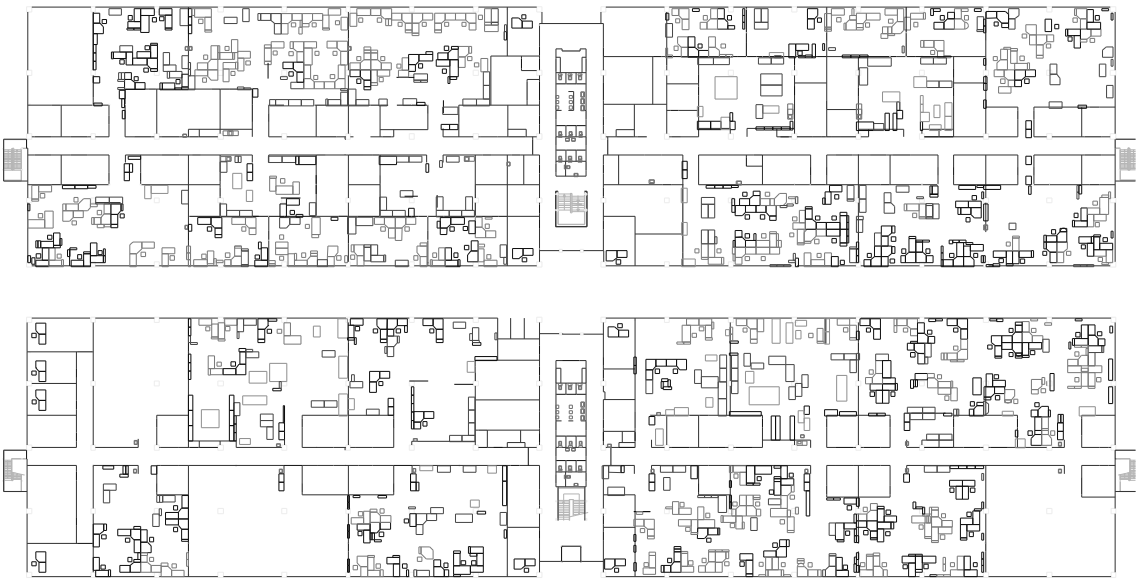


Figure v Layout case building.



4.1 Data description

On average, participants had 14 KS meetings this week with five different colleagues, which were mostly one-on-one meetings and took place at a workplace (78%) or in a lab area (14%). The hallway and coffee machine might be places where a lot of talking takes place, but not to share work-related knowledge in the way that was studied here. Questions were the most common way to share knowledge (56%), but the other four KS activities also took place (±

20%). During a day, an average of 45 minutes was spent in unplanned KS meetings, with 80% of the meetings lasting up to 15 minutes. The knowledge that was shared appeared to be very tacit, because it was often (77%) available through one person only. Most meetings were intentional (72%) and concerned a problem (89% of which 44% was a shared problem). Involvement in each other's problems was generally high (3-5 on a 5-point scale).

An AutoCAD drawing with both floors was imported into Depthmap, and a grid of 0,50 x 0,50 meters was placed over the entire layout to generate the metrics. On average, a participant:

- had 15 m^2/workplace,
- saw 7 roommates from behind his/her desk,
- sat 8 meters from the entrance,
- had a visible room size of 168 m^2 and
- had an average walking distance of 61 meters to the other workplaces in the building.

Participants were spread over the rooms (so some were in the centre, others at the outskirts). The group offices provided their inhabitants with a more compact and smaller work area, than the larger, rectangular, open areas. 63% of the participants was visible from the entrance of the room.

As the amount of KS meetings was not spread normal, Spearman's correlation had to be used to test the conceptual model. The five categories of KS activities (descriptions, questions, actions, proposals, evaluations) and other KS indicators (location, intentionality, initiator, alternative source, involvement) were visualised and tested with χ^2-tests for possible differences in KS behaviour for certain values of the layout metrics.

4.2 Findings

From the three mechanisms identified from literature, only accessibility and centrality had a significant association with the amount of KS meetings for this organisation and this context (see Table 2). Apparently, the exposure mechanism was not triggered at Océ. Looking at the correlations of the metrics used, the strongest ones belong to the accessibility mechanism. However, it appears to include two different groups of metrics. In literature, accessibility is also used sometimes for visibility and sometimes for placement issues. So, it seems better to split accessibility into these two different mechanisms. Visibility of colleagues appeared to have increased the amount of KS meetings the most with a correlation of .355 (see also figure vi). The placement within the room metrics showed that there must be a limit to the visibility mechanism, because an increase in average walking distance to roommates (and decrease in density) lowered the amount of KS meetings (correlation = .181). An optimum room size did not come forward. The centrality metric showed the expected decrease in number of KS meetings with an increase in distance (correlation = .183).

A closer look at what happened during the KS meetings, showed more significant influence of the mechanisms for this organisation. Participants with many visible workplaces had significantly more KS meetings at the coffee machine ($\chi^2(12, N=1880) = 23.683$, $p < .05$). More visibility also increased the amount of intentional visits ($\chi^2(1, N=1891) = 7.360$, $p < .01$). And the participants with fewer visible workplaces mentioned more often that another person than the one they met could have provided the same knowledge ($\chi^2(6, N=949) = 14.319$, $p < .05$), which makes the knowledge they shared less tacit. Placement within the room significantly influenced

which KS activities were used to share knowledge ($\chi^2(4, N=1379) = 10.972$, $p < .05$). Sitting closer to each other seemed to increase awareness and prompt people to give more descriptions. At a distance, it appears necessary to ask things that might otherwise have been clear by overhearing/awareness. The participants at the 'outskirts' of an area also seemed to have more opportunity there to evaluate or perform actions together. Participants in more dense environments used meeting areas more often; possibly not to disturb the others ($\chi^2(5, N=1758) = 11.412$, $p < .05$). Centrality showed no further differences in KS behaviour. The exposure metrics had no association with the amount of KS meetings, but did show differences in the KS activities that were chosen. Participants visible from the entrance used descriptions and actions significantly more often to share knowledge ($\chi^2(4, 1379) = 16.409$, $p < .01$). Perhaps the visible participants were consulted more for quick needs for a description or to help with an issue, when people entered the room.

Table 2 Correlation between layout metrics and amount of KS meetings

Mechanism	**Spearman's rho correlation**
Visibility (accessibility)	
• Visible workplaces	.355**
• Compactness	-.328**
Placement within the room (accessibility)	
• Density	.181*
• Location inside the room	.168*
Centrality in the building	
• Average walking distance to all workplaces	-.183*

** Correlation is significant at the 0.01 level (2-tailed).

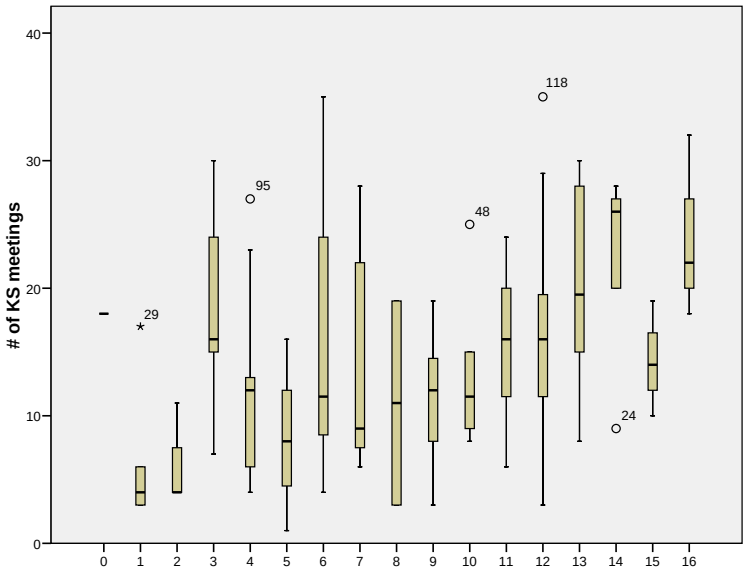
* Correlation is significant at the 0.05 level (2-tailed).

5 DISCUSSION AND RECOMMENDATIONS

Overall, the association of layout with the number of KS meetings at the case organisation (Océ) was not really strong. The strongest association (.355) is still considered 'moderately strong' for Spearman correlations in general. But it does show how FM can add more use value through considering the influence of the layout on this important organisational process. FM is a supportive resource, and it cannot be expected to be responsible on its own for a high variance in the amount of KS. Other context variables (e.g. organisation structure, culture, working on the same project) will be responsible for the largest part of this variance (hence the use of realistic evaluation). But even if only 20% of the variance would be explained, this means that FM can support and improve the primary process of their client organisation significantly, and that is their main task. The methodology used gave FM insight in the relevance of metrics within their organisational context and in the current workplace effectiveness.

A face validity test showed the findings to be clear and interesting and Océ could identify with them. Also, they felt that the layout metrics represented their building correctly. They mentioned that KS at Océ does indeed take place similarly as the results from the logbooks showed. Projecting the results from the case-study on the new layout gave insight in the KS that should take place after the renovation program is implemented. The facility manager was happy with this, because it helped him show the added value of the new layout to general management.

Figure vi Visible workplaces and the # of KS meetings.



It will be necessary to have a relevant list of (layout) metrics for each different added value as mentioned in the introduction, to prove in general how real estate interventions trigger the desired mechanism(s) of an organisation. Each FM department will have to look within their own 'black box' and see how layout mechanisms are best implemented to support the specific goals of their client. FM will have to cooperate with other business functions on this, to make sure that the right needs are supported. Results of an internal benchmark with the quantitative metrics explored in this paper can then be discussed in briefs with architects and other external parties. They can also be used to compare alternatives, using the actual layout drawings from an architect. This way the tacit knowledge of architects on how layout influences behaviour can be made explicit and discussed with clients with less knowledge of building design.

Some metrics were easy to generate and monitor, while others took considerably more time and effort. Some layout metrics (compactness, centrality) demand an automated approach (Depthmap) because it was too much work to calculate them manually. A downfall of this is that only the programmer knows the computer program by heart, so the users might be stuck with the feeling that they miss the due diligence possibility of manual approaches (Brown, 2008). Océ indicated that they would only use such metrics for buildings with complicated layouts or if they would start regularly monitoring many buildings. This is for each FM team to decide, after they have explored the relevance of metrics and mechanisms for their specific context.

Realistic evaluation emphasizes the influence of context on outcome, and how mechanisms might or might not be triggered to produce an outcome. The influence of context on the outcome became clear as not all mechanisms from previous studies were triggered at Océ. So Realistic Evaluation is a good basis for these types of studies that combine spatial mechanisms and effectiveness outcomes. Realistic evaluation allows the combination of different methods of data collection. For this research, the logbooks gave clear data on the questions that were asked, but in retrospect could have been supplemented by a follow up survey. This could have gone deeper into the knowledge gathered from the logbook analyses.

Many recommendations for further research can be distinguished. This study looked at face-to-face meetings only. Among CRE practitioners, virtual cooperation still has a very low priority (Gibler, Lindholm and Anderson, 2010). But there are academics that have studied the use of technology for remote collaboration (Covi, Olson and Rocco, 1998), like email, phone and all kind of internet applications. Even some comparisons have been made between face-to-face and distant communication (e.g. Heerwagen et al, 2004). Studies looking at both forms of communication showed that ICT cannot replace the necessary face-to-face communication for KS. It has advantages (more open and democratic), but also disadvantages, for example that people communicating electronically have a hard time imagining what others are feeling (Sproull and Kiesler, 1991). It is not possible to share complex information without the feedback available by the presence of the other person (Allen and Henn, 2007). Studies (Allen and Henn, 2007; Spiliopoulou and Penn, 1999) did find that people mix the media that they use, so people with more face-to-face communication also communicate more through other media. With the rise of innovative ICT tools, the ability to virtually share tacit knowledge should be studied further.

Social networks are also very important for collaboration, as they help structure access to knowledge and knowledge transformation (Wineman et al, 2013). The tie formation for these networks is influenced by the layout (Sailer and McCulloh, 2012). But Wineman et al found that spatial measures and social network measures have individual contributions to innovation outcomes. It would be interesting to further study their relative impact and how spatial and social networks can enforce each other.

In this organisation, hardly any unplanned meetings took place in designated meeting areas. This does not mean that meeting areas are not relevant in other contexts. The case building only had very standard meeting rooms. To study this mechanism in depth, cases must be sought that deliberately use a range of meeting places to create certain conditions. Then it can be tested whether and how this mechanism works. The activity based office concepts related to the trend of New Ways of Working do have many specifically designed places to incidentally sit down for a short (or longer) chat. It should be studied how all these types of meeting areas influence (KS) behaviour. As activity based offices often have large open areas (too large according to our results), they might show different results for all mechanisms. As these offices are based on non-dedicated seats, people can use different types of workplaces during the day. This will influence who they meet, and how they share knowledge with them. Exposure should be studied further as well to understand the mechanism better in more and less open layouts, and in these activity based offices. Perhaps then an optimum room size can someday be determined.

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