VIRTUALITY – WHAT DOES IT MEAN FOR FM?

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It has been speculated that virtuality will have a dramatic impact on the use and design of physical space. Especially for those involved in facilities management (FM), this trend is already easily observable. This study aims to clarify what virtuality really means for facilities management. The clarification is backed by taking a view of what virtuality is and what it could be to companies from different industry sectors. The study was conducted by reviewing literature on virtuality as well as collecting and analyzing data on the case companies. In the literature review, two different concepts of virtuality were identified. Problems arise when the concept of virtuality used is not clearly specified. The term, as well as many other terms related to the subject, is often misused. This paper provides examples of the division and then further explains the roles of the two different virtualities in facilities management. Findings conclude that companies in the industry seem to leave a lot of virtuality's potential untapped and that more consistent and precise use of terms is needed.

Keywords: information technology, value creation, virtuality

INTRODUCTION

During the past few decades, as information technology (IT) has intensified most office work tasks and also enabled a number of new ones, it has gradually gained its current position as an irreplaceable part of an office worker's work setting. IT has naturally gained attention in the scientific world as well. Not only in the field of computer science, as the most obvious one, but also in other fields that are more concerned about the implications that adopting IT has rather than the technology itself. Organizational science is a good example of these other fields of science. In organizational science, IT-supported work has become widely referred to as virtual work. The same meaning for word 'virtual' has been adapted to a number of terms further forming the whole concept of virtuality. This concept of virtuality seems not to be unambiguous (Fang & Dutta 2005). In facilities management (FM) research the concept of virtuality referred to is the one adapted from organizational science (Roulac 1996; Becker 1998; Hinks 2002; Joroff 2002; Joroff et al. 2003). Most cases where virtuality is mentioned relate to workplace management as a part of facilities management. Workplace management has a strong connection to organizational science and this means that a similar approach to virtuality is taken.

Nonetheless, the organizational science approach is not all there could be to the entity of virtuality from the perspective of FM. Through examples from the industry, this paper presents a parallel perspective to virtuality that cannot simply by its definition be the same virtuality that is dominant in organizational science. The study approaches virtuality from a clearly wider perspective than previous FM research and intends to present a more comprehensive depiction of the entity of virtuality. Also, this paper addresses some obvious problems in the present discussion of virtuality. This paper does not follow the common structure of a scientific article in that some of the results and conclusions are being presented already in theory. This is because a significant part of the findings of the study is based on the literature review. In the first part of this paper, the definition for 'virtuality' is elaborated from the definition of 'virtual' and the identified duality of virtuality is explained. In the second part the two virtualities are described separately and then the implications of this duality are discussed. The third part considers the two virtualities in the context of today's facilities management and the potential utilization of virtuality is further discussed.

DEFINING 'VIRTUALITY' THROUGH DEFINING 'VIRTUAL'

The variety of different aspects to virtuality and the relatively early stage of its adoption to different fields have led to the existing manifold terminology regarding virtuality. Some of the terms used are rather hazy and many have a number of synonyms. Also, the term virtuality has become vaguely used. It is often referred to without even the slightest intention to really consider what it means. A clarification of its meaning needs to be addressed. As virtuality does not yet have an established uniform definition, it needs to be defined by examining its root word virtual. Therefore, the literature review focused on different usages of the words 'virtuality' and

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'virtual' in the context with some relation to FM. Instead of going through the evolution of the word 'virtual' from the Latin word 'virtus' (proficiency, virtue, manliness), let's focus on what it means in today's language. The dictionary definition is in general terms "almost or nearly as described, but not completely or according to strict definition" and in computing "not physically existing as such but made by software to appear to do so" (Oxford Dictionaries 2011). Lipnack and Stamps (2000) have three contemporary meanings for virtual:

- 'Appears to Exist' meaning; virtual is something that is not real, but appears to exist and appears real to the senses;
- 'Almost Like' meaning: virtual is not the same, but almost like or in essence the same as its non-virtual equivalent; and
- 'Virtual Reality' meaning: virtual as it is in 'virtual reality', "a recent meaning invented for an emerging capability"

According to Lipnack and Stamps' (2000) philosophy of virtual, which falls in the organizational science category, the authors use the 'Almost Like' definition, as a virtual team is in many ways similar, but also critically different from a conventional team working together in the same place. 'Virtual' is used similarly in terms 'virtual organization', 'virtual corporation', and 'virtual office.'

The 'Appears to Exist' meaning Lipnack and Stamps (2000) disprove by saying that when they talk about virtual teams, they mean teams that certainly are real and not electronic representations of the real thing. The newest 'Virtual Reality' meaning they do not accept as it would attest "…to forces that have moved teams into an altogether different realm of existence – virtual reality – or, more precisely, digital reality. Electronic media together with computers enable the creation of new kinds of spaces. They are real to the groups that inhabit them, yet are not the same as physical locations" (Lipnack & Stamps 2000).

Taking a closer look at the 'Appears to Exist' and 'Virtual Reality' meanings presented by Lipnack and Stamps (2000) – how recent in fact is the meaning of 'virtual' as it is in virtual reality? Also, how different really is this meaning from the 'only appears real to the senses but is not in fact'? Going back to the computing-related definition of 'virtual', where virtual does not physically exist as such but is made by software to appear to do so. This would be exactly the same as in virtual reality when virtual reality is a synonym for a digital representation of either the real world or of an imaginary world that aims to mimic something that could really exist and to deliver the perception of this to the observer. But isn't the computing-related definition for 'virtual' also exactly the same as the 'Appears to Exist' definition, only with the specification of using software to achieve this status?

Instead of attesting to any forces, the writers of this paper suggest that virtual reality is just an application of emerging technologies exploiting the idea of virtual in the meaning "appears real to the senses" and does not demand its own definition for 'virtual'. This leaves us with two relevant definitions for 'virtual', which both have their place in FM. The following section introduces the two different virtualities to which the two described definitions of virtual respectively relate.

THE TWO VIRTUALITIES

In the literature, two different virtualities relevant from the FM perspective can be identified: organizational virtuality and digital representation virtuality (DR-virtuality)[ii]. In the following those are described first individually and then discussed together in broader context.

ORGANISATIONAL VIRTUALITY

The term 'organizational virtuality' has not been in such widespread use as for instance terms 'virtual organization' and 'virtual team'. The term should be in more widespread use as it specifies the type of virtuality at issue. In FM research, when referred to virtuality, it's often the organizational virtuality which is dealt with – whether the particularization is made and expressed or not (Roulac 1996; Becker 1998; Hinks 2002; Joroff 2002; Joroff et al. 2003). For organizational virtuality the 'Almost Like' i.e. "people acting virtually like an organization, a team, etc." definition by Lipnack and Stamps (2000) for 'virtual' fits well. It supports the exhaustive definition for organizational virtuality presented by Fang and Dutta (2005). Based on the virtual organization literature and the knowledge-based view, they have elaborated a definition for organizational virtuality as "the capability of an organization to connect geographically dispersed entities to continuously work together by taking recourse to information system (IS) resources".

Fang and Dutta's (2005) major characteristics of a virtual organization (geographical dispersion, functional diversity and extensive use

ii. The writers of this paper wish to emphasize that the term DR-virtuality was generated as a part of the study for notation of the other identified virtuality. The term is not suggested to be used otherwise than for the distinction of the virtuality at issue.

of information technology) are rather vague, but this is in fact a good summary of the great number of characteristics named for virtual organizations in the literature. Other characteristics that occur in the literature include for example shared purpose/common interest, diversity of people or cultures, and temporal dispersion (asynchronous collaboration). In addition to being intra-organizationally virtual firms can be interorganizationally virtual. Outsourcing is an example of interorganizational virtuality (Fang & Dutta 2005).

Virtuality in an organization can also be approached through virtual space. It is a part of the concept of dividing space into physical, virtual and mental/social spaces, which has risen especially in the past decade to become a part of organizational study. This division has been used for instance by Vartiainen (2006; 2008), who bases it on Nonaka et al.'s (2000) work. Nonaka et al. (2000) introduced the Japanese concept of 'ba' as a shared context where knowledge is created, shared, and utilized in. As they plant the concept of 'ba' into today's work setting, they bring up the notion that it does not necessarily mean only physical space, but rather "unifies physical space such as an office space, virtual space such as e-mail, and mental space such as shared ideals."

Vartiainen (2008) – while strongly focusing on mobile work – claims that it's the physical, mental/social, and virtual working spaces where individuals and groups collaborate today. Virtual space – the most important one from the perspective of this study – he describes as an electronic working environment, a virtual work space or a collaborative working environment consisting of various tools and media for individual employees, groups, and whole organizations. As these tools and media Vartiainen (2008) lists among others Internet, intranet, e-mail, videoconferencing, document management, smartphones, groupware systems, and social software. Overall, Vartiainen's (2006; 2008) view to virtual organization is that a fully virtual organization communicates and collaborates through ICT in the mental and virtual workspaces. This is in conjunction with Lipnack and Stamps' (2000) definition for virtual team as a group of people working interdependently, but with a shared purpose across space, time, and organization boundaries using technology. Both of these views, as well as Fang and Dutta's (2005), obviously emphasize the importance of technology for a virtual organization. Even if some researchers do not find use of ICT a defining characteristic for a virtual organization, it seems that most have the same approach as Vartiainen (2006; 2008) for example. This approach concludes that an organization is not virtual without ICT enabling communication and collaboration.

DR-VIRTUALITY

In the introduction of this paper it was claimed that the virtuality often referred to in FM research, above defined as organizational virtuality, is not all there could be to the entity of virtuality from the perspective of facilities management. The rationale behind this is easiest approached through an example. An example would be a three-dimensional virtual model of a building created using computer-aided design (CAD) software, often recognized as the 'embodiment' of building information modeling (BIM). What makes this digital 3D-representation of an existing or planned construction virtual? It hardly is virtual for the same reasons the virtual organization is; geographical dispersion, functional diversity, and use of information technology as Fang and Dutta (2005) described.

This is where the 'Appears to Exist' definition for 'virtual' steps in. This definition is in conjunction with the other virtuality referred to earlier – DR-virtuality. The logic behind the name digital representation -virtuality is rather simple: what seems to characterize this virtuality is the use of the concept of the virtual environment (VE) – and more precisely – 3D virtual environment as a digital representation of something also observable or imaginable in the real world. One commonly known example of the usage of the word virtuality as a synonym for a three-dimensional virtual environment is the concept of reality-virtuality continuum (RV continuum). Milgram and Kishino (1994) presented their idea of a continuous scale between reality and virtuality, where there is completely real environment at one end and completely virtual environment at the other end. The widely used graphic presentation of the RV continuum is shown in Figure 1 below.

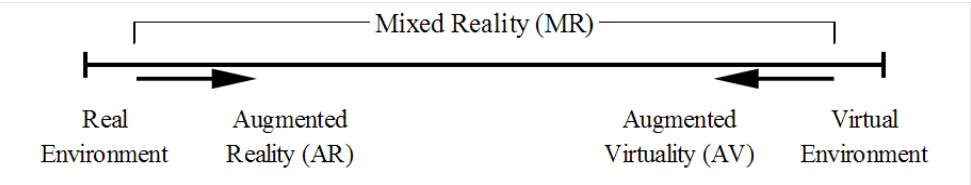

Figure 1: Simplified representation of a RV continuum (Milgram et al. 1994)

While real environment is quite self-explanatory, the other end of the continuum might need some clarification: "The conventionally held view of a Virtual Reality (VR) environment is one in which the participant-observer is totally immersed in, and able to interact with, a completely synthetic world. Such a world may mimic the properties of some real-world environments, either existing or fictional…" (Milgram & Kishino 1994).

The problem with the above concept, according to Milgram and Kishino (1994), is that virtual reality is also often used with reference to many other environments that are not completely synthetic and do not offer total immersion. These environments fall somewhere along the reality-virtuality continuum and represent mixed reality (MR). In MR environments, real objects are presented together with virtual objects within a single display. The methods for this are either augmenting real environments with virtual objects (augmented reality, AR) or augmenting virtual environments with real objects (augmented virtuality, AV) (Milgram & Kishino 1994). One example of AR technology is wearable or handheld devices, such as smartphones, that shoot the real environment with a camera and then show it augmented with virtual objects in a display (video see-through). Examples of applications for AR include visualization of a 3D-modeled building in its planned environment and visualization of planned furnishing in an existing building.

AV can be created for example by shooting a real object with a camera and placing it into the virtual environment. This is then observed through a visual display. AV applications for the use of FM in particular are few. Overall, the applications of DR-virtuality are various. The strong connection DR-virtuality has on FM comes from the fact that the 3D virtual environment is a digital presentation of physical space which is an essential part of FM. One of the main drivers for utilizing DR-virtuality has been avoiding the potentially high cost of trial-and-error. This cost may be for example in money (in the case of prototyping, production and manufacturing process simulation, BIM, etc.) or in human health (in the case of simulators for air and spacecraft pilots, emergency procedures training, etc.). Even if developing different DR-applications is expensive, they come at a low cost compared to the real-life trial-and-error.

As different DR-virtuality applications are becoming easier to use and to produce, their utilization is becoming more affordable. This means that the driver for utilizing DR-virtuality no longer needs to be for example the avoidance of very high cost of trial-and-error as it has been in older simulation applications. We can already observe DR-virtuality coming to many everyday applications – for example in smartphones and tablets, where it is not only about avoiding high cost, but also creating new business in a number of ways.

IMPLICATIONS OF THE DUALITY OF VIRTUALITY

Despite some divergent interpretations, it seems that for organizational virtuality the key words are collaboration, dispersion and ICT. If taken the technological approach, it seems no particular technologies need to be named, as the only purpose for technology is to support collaboration of a team or organization, whose members are dispersed in terms of geographic location for instance. So even if technology is a defining characteristic for organizational virtuality, technology seldom is in the main focus when examining organizational virtuality. DR-virtuality perspective is much more technology driven. It seems to be more about studying what virtual environments could offer to a specific industry, field of science, or group of people and what are the consequences of applying DR-virtuality in the object. For DR-virtuality, the idea is creating something that only exists in a digital form, but gives the observer the feeling that it could also exist in a more tangible form.

From the technology perspective, there are some areas where the two virtualities overlap as depicted below in Figure 2. A good example of this overlap would be the collaborative virtual environment. The environment could be three-dimensional and highly immersive to the user, thus being at the core of DR-virtuality, but at the same time serve as a shared environment, where a team could collaborate as if they were all present in the same physical space despite being spread around the world.

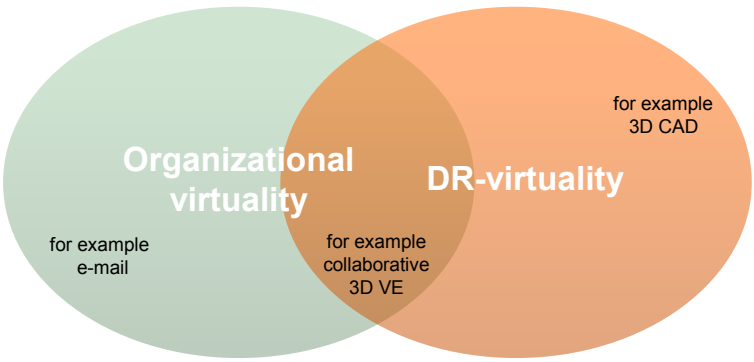

Figure 2: The two virtualities

On the other hand, in both virtualities there are areas that fall clearly very far from the other virtuality. An example is e-mail. It is a tool that most virtual organizations use. It represents ICT, so when used by a dispersed team for collaboration it would be enough to fill the technology-requirement for the team to be virtual. But how about when viewed from the other virtuality-perspective – there is in fact nothing virtual about e-mail; the connection between e-mail and 3D virtual environments is extremely remote. Similarly there are a number of 3D VE-applications that need not to aim at any kind of collaboration. They can be used by a single user only, and solely for the user's own purposes (for instance a CAD-application). Clearly, then it is not even possible to speak about an organization or a team whatsoever; thus, the application has nothing to do with organizational virtuality.

Basically the existence of the different virtualities is not a problem as long it is made clear which one is at issue, in fact, virtuality should never be referred to without being more specific. What seems to potentially cause problems in the current discussion regarding virtuality is terminology. Usage of prefix 'e-' and words 'digital', 'virtual', and 'cyber' to produce new terms has become very confusing. In some cases there are multiple terms for the same object or the same term for multiple objects. The term 'virtual space' is a good example of how one term has multiple uses. Above virtual space was described as a working environment, with various tools including e-mail, document management, smartphones etc. Virtual space may also refer to a virtual representation of the space (where one can observe stars, planets, etc.). In addition, virtual space is often used as a synonym for three-dimensional virtual environment.

CASE STUDIES – EXAMPLES OF THE TWO VIRTUALITIES

The aim of the study was to clarify what virtuality means for facilities management. To support this, a study of how virtuality is and how it could be utilized in the industry was conducted. The relevance of different applications of virtuality was evaluated on the capability of creating value to the end-customer, who would in most cases be the user of the space. The empirical part of the study was conducted by applying the identified concepts of virtuality into three case studies and simulating a hypothetical situation how value creation could be improved by utilizing different applications of virtuality.

The investigation was limited to technological applications as technology turned out to be what links the two identified virtualities. The intention was not to find new technologies for FM, but to investigate which technologies (software and hardware) are currently in use and which should be in order to achieve improved value creation. Some practical aspects such as limited availability of technologies, high cost, or other such obstacles were not considered. This means that some of the suggested technologies are not easily utilized yet today.

BACKGROUND AND DATA COLLECTION OF THE CASE STUDIES

The two concepts of virtuality were applied in three case studies. In the first case study, the focus was on how the value creation processes allowed the property manager and the owner to take care of their end-customers' daily life issues in an office environment. In the second case, the scope was narrowed to strategic workplace management services. The mechanisms and structures, which were not supporting the value creation, were identified from the business processes. In the third case study, the aim was to understand how a construction company could create value for nursing homes by their nursing home product.

The three cases have been structured around four steps. First, the end-customer value was identified by interviews and questionnaires. Second, the current value creation process was recognized by interviewing employees of the companies who were actually creating the value. Third, the identified value creation process was reflected against value creation theory in workshops, brainstorming sessions and case study analysis. Fourth, ways to improve value creation utilizing the two virtualities were formed and analyzed based on the capability of creating value to the end-customer.

DISCUSSION ON THE POTENTIAL UTILIZATION OF THE TWO VIRTUALITIES

Based on the case studies, the identified technological applications of virtuality that could potentially improve value creation in FM are BIM, virtual model of a building, integration of information systems, and telepresence.

Integration of information systems

In each of the studied cases, the setting is very strongly interorganizational. All the studied organizations rely on their surrounding networks of organizations, which comprise of actors such as end-customers, service providers, contractors, sub-contractors, and property owners. In order to be able to rely on the network, the information received from other actors must be reliable.

In the case of optimum efficiency, information is not only reliable, but also timely. In order to achieve this, human errors and delays in service could be prevented by making the information systems of different organizations communicate among themselves and by allowing shared access into an information system across the network where necessary. The cases showed that this is not where we are today. In fact, it is not only the interfaces between organizations, but also inside the organizations where the same data is re-entered or processed manually, which causes inefficiencies. The downside with making 'computers communicate among themselves' is the lack of personal service, which is appreciated among some end-customers. This means that one is forced to make a decision; the trade-off is timely/accurate service and individual/personal service.

Telepresence

Information flows played a crucial role in all cases studied. Arranging sufficient and effective means for communication absorbs lots of resources. Through development of telepresence technology, some of the interaction tasks that used to demand physical presence can today be carried out remotely; this development is still on-going. The technology for telepresence ranges from simpler videoconferencing equipment to more sophisticated mixed and virtual reality collaborative environments. Telepresence applications can be considered something enabling 'just-in-time-presence' and offering 'just-in-time-conference space', which means improved time, cost and environmental efficiency as traveling can be avoided. In the case where meeting physically would otherwise be impossible, telepresence applications can create improved value instead of just making value creation more efficient.

Building information modeling (BIM)

Among those who are not that familiar with BIM, it is often considered a 3D virtual model of a facility. The 3D model is only the visual presentation of the model and serves as an important part of BIM software's user interface. The 3D virtual model means that BIM represents DR virtuality, but BIM is a strong tool for collaboration, thus representing organizational virtuality. As BIM is much more a collaboration tool than just a visualization tool, the virtual model part is discussed separately. Aside from the 3D model and its utilities, BIM is used for document and information management, project management, estimating, scheduling, simulation, and analyzing a number of factors related to feasibility, costs, energy, and environmental performance. Server BIM enables even better collaboration and higher efficiency in the early stages of a building's lifecycle as all the designers will have the latest model and information in their use (Eastman et al. 2011). BIM's advantages are not restricted to only the designing and construction phases, but can be seen through the lifecycle of the building. BIM can help in managing the real estate portfolio of an owner or a user in many ways: planning and budgeting of a renovation project, analyzing space use, and managing environmental and cost performance of operation. The cases show potential for BIM through a building's lifecycle. Research showed that it is underutilized in the operation of a building.

Virtual model of a building

As BIM systems used in the construction are relatively heavy and complex, less sophisticated applications are needed for visualization and measuring purposes. When a new building is built using BIM, for example the geometry and material data is there in the model ready for also other than construction-related uses. It would often make sense to prepare a virtual model of an existing building which has not been built using BIM. The virtual model of a building, an application of DR-virtuality, can enhance value creation to the end-customer in a number of ways. Its applications – whether as part of the BIM or as a simple virtual model of the existing or planned facility – are various. For example the following uses were identified as potentially improving value creation: simulating use of premises prior to construction, visualization consummating communication between end-customer and designer (also by AR applications), reorganizing space use, planning space change needs, and marketing of space. The advantage of a virtual model comes mainly from the ability to depict plans in 3D instead of 2D. This is one means of avoiding the cost of trial-and-error.

IMPLICATIONS FROM THE CASE STUDIES

Studying the case companies from the perspective of the concepts of virtuality described earlier in this paper made the underutilization virtuality evident. BIM, virtual models, integration of information systems, and telepresence are applications of virtuality that could potentially improve value creation in FM. Virtuality and technology are not the only things connecting the applications listed. Another common factor is that all the applications help in managing information flows inside or between organizations. Information flows and managing them seems to be of crucial importance in each of the cases studied and for this purpose, virtuality is one of the most suitable tools. Virtuality should not only be considered as a means of making things more efficient. Virtuality potentially enables creating added value to the end-customer from the owner (as the landlord), from the builder of new and renovated premises and from the facilities management unit.

CONCLUSIONS

The aim of the study was to find out what virtuality means for facilities management. Based on the literature on virtuality, the different concepts related to virtuality were identified and elaborated where needed. Case companies from the industry were studied from value creation perspective by conducting interviews, questionnaires, and workshop meetings. The different concepts of virtuality were then reflected against the data from the cases. The literature on virtuality can be described as being rather colorful. Also, references made to virtuality are often unscientifically vague. Approached from the perspective of FM, two relevant concepts for virtuality were identified in the literature: organizational virtuality and digital representation virtuality. What separates these two virtualities on a conceptual level is the different definition for the word 'virtual'. The strongest link between the two virtuality concepts is technology.

The case studies showed that some of virtuality's potential is currently left untapped. Four technological applications of virtuality were suggested for not only making value creation more efficient, but also for potentially creating added value to the end-customer. Most of virtuality's current potential lies in improving information flows. Virtuality being such an interdisciplinary subject means it has been and will be viewed from various perspectives. At the edge of digital revolution, it became a universal buzzword. This is easily explained by the interdisciplinarity and the intangible nature that virtual has. The use of words 'virtuality', 'virtual', and many related terms should become more coherent. If it is about dispersed, mobile, digital, or collaborative, why not to use the respective term instead of the term 'virtual'?

The main limitation of the study is that the value delivered to the end-customer and its improvements by means of virtuality was not quantified. This is due to the obvious difficulties that come with such broad approach as the entity of 'virtuality'. More precise outcomes in terms of the quantity of achievable improvements could have been reached with a more narrow approach than just 'virtuality'. Also, the study did not consider the reasons for underutilization of virtuality applications. The attempts to really grasp virtuality's essence are few. With organizational virtuality Fang and Dutta (2005) have given their effort. This paper intends to take a wider view to the essence of virtuality. For future research on virtuality, an even broader, more interdisciplinary perspective is suggested. A more thorough study on the concepts and terms of virtuality is needed. In future research related to virtuality, a more precise use of terms is suggested. In general, when dealt with virtuality, the distinction made in this paper needs to be noted.

REFERENCES

Becker, F. (1998) Beyond alternative officing: Infrastructure on-demand "Journal of Corporate Real Estate", 1(2), 154-168.

Eastman C., Teicholz P., Sacks R. and Liston K. (2011) "BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors". 2ed. Hoboken, NJ, US: John Wiley & Sons, Inc.

Fang, Y. and Dutta, D. (2005) Explaining Organizational Virtuality: Insights from the Knowledge-Based View. In "Eleventh Americas Conference on Information Systems", 11-14 August 2005, Omaha, NE, US. AMCIS, 3537-3544.

Hinks, J. (2002) The transition to virtual: The impact of changes in business operations on facilities management. "Journal of Facilities Management", 1(3), 272-282.

Joroff, M. L. (2002) Workplace mind shifts. "Journal of Corporate Real Estate", 4(3), 266-274.

Joroff, M. L., Porter, W. L., Feinberg, B. and Kukla, C. (2003) The agile workplace. "Journal of Corporate Real Estate", 5(4), 293-311.

Lipnack, J. and Stamps, J. (2000) "Virtual teams: people working across boundaries with technology". 2ed. New York, NY, US: John Wiley & Sons, Inc.

Milgram, P. and Kishino, F. (1994) A Taxonomy of Mixed Reality Visual Displays. "IEICE Transactions on Information Systems, E77-D (12).

Milgram, P., Takemura, H., Utsumi, A. and Kishino, F. (1994) Augmented Reality: A class of displays on the reality-virtuality continuum. In "SPIE Telemanipulator and Telepresence Technologies", Boston, MA, US. SPIE, Vol. 2351, 282-292.

Nonaka, I., Toyama, R. and Konno, N. (2000) SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation. "Long Range Planning", 33(1), 5-34.

Oxford Dictionaries (2011) Definition of "virtual" from Oxford Dictionaries Online. "Definition of virtual from Oxford Dictionaries Online". Available at: http://oxforddictionaries.com/definition/virtual [Accessed September 30, 2011].

Vartiainen, M. (2008) Facilitating Mobile and Virtual Work. In C. Wankel, (ed.) "21st century management : a reference handbook". Los Angeles, CA, US: SAGE Publications.

Vartiainen, M. (2006) Mobile Virtual Work – Concepts, Outcomes and Challenges. In J. H. E. Andriessen and M. Vartiainen, (eds.) "Mobile Virtual Work: A New Paradigm?". Berlin, Germany: Springer Berlin/Heidelberg.