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Abstract

This paper presents the results of a study investigating the factors affecting information and communication technology (ICT) adoption in the supply chain of facilities management in Denmark. The study takes the starting point in the literature of supply chain management, facilities management and ICT adoption to conduct a qualitative study of factors impacting ICT adoption in the Danish facility management supply chain. The results show that there are a number of drivers and barriers that influence adoption of ICT in the Danish supply chain of facilities management. These have been grouped under 3 major categories. Organizational factors include strategic and operational factors; external environmental factors include supplier interdependence and industry characteristics; technological factors include compatibility and complexity. The study is relevant to researchers of ICT adoption and operations management (especially facilities management) as well as operation managers and ICT managers alike.

Key Words: Supply Chain, ICT, Adoption, Facilities Management Services

1   INTRODUCTION

In the last decade or so, companies have outsourced many of the corporation's functions to external suppliers. The driver for outsourcing being the ability to shift non-core services out of the organization, to allow the organization to better focus on the proprietary functions - those functions that give the organization the competitive advantage. This is also the case for non core-services such as facilities management (e.g. Rogers, 2005; Ventovuori, 2006). Organizations need to ensure they do not lose sight and control of the outsourced services, especially if the supplier becomes dependant on driving up volumes in order to remain profitable, to the detriment of quality and innovation (Rogers, 2005). Thus, lately, the role of supply chains and their management has increased importance (Christopher, 2000; Moberg et al., 2003). In addition, supply chains in every industry are moving toward integration as the demands on individual organizations have become too vast to allow them to continue operating in isolation (e.g. Rogers, 2005; Christopher, 2000; Skipper et al., 2008).

The advent of Web technologies and related supply chain management systems is also facilitating planning, collaboration and integration of supply chain partners (e.g. Johnson and Whang, 2002; Rudberg et al., 2002) as well as is creating value throughout the supply chain (Loforte Robeiro and Love, 2003; Meixell, 2006). However, the adoption and assimilation of ICT systems to support the supply chain is often largely contingent upon the extent to which the system is assimilated internally and diffused among networks of business partners in a supply chain (Ranganathan et al., 2004). Previous literature on Interorganizational Systems (IOS) adoption has showed that such adoption process is not easy and there are a number of factors that influence it (Jeyaraj et al., 2006; Harrison and Waite, 2005). In this study I focus on the factors that affect adoption of ICT systems in facilities management supply chain and investigate the following research question: What are the key factors that influence adoption of ICT systems in the supply chain of facilities management in Denmark? Facilities management is defined here as a support activity supplying facility services to support the demand of the primary activities in an organization, thus facility management is a specific type of service management (Jensen, 2008). Examples of facility services include cleaning of the office space and maintenance of buildings (Jensen, 2008). Few studies have investigated supply chain management in facility management services especially with focus on ICT adoption (e.g. Vandaele and Gemmel, 2007). Therefore the importance of this study lies in the generation of new knowledge about factors affecting ICT systems adoption in the supply chain of the facilities management industry in Denmark, which might be of interest to scholars and practitioners in the fields of facilities management, ICT adoption and operations management.

The article is structured as follows. In this section the background and the research question have been introduced. In the second section a brief overview of the Danish facility management market is provided. In the third section a literature review of supply chain management, facilities management and ICT adoption with special focus on the supply chain is given. In the following section the research method is described, while the next section presents the study's results. Finally the last section will discuss the results and give some concluding remarks and suggestions for further research.

2   LITERATURE REVIEW

Three main streams of literature form the theoretical background of this study: the facilities management literature (e.g. Jensen, 2008; Alexander, 1996), the literature on supply chain management (e.g. Christopher, 2000; Moberg et al., 2003), and the innovation diffusion literature (e.g. Rogers, 1995). However, being the main focus of the paper ICT adoption, we mainly provide here some basic understanding of supply chain management and facilities management.

2.1 Facilities Management (FM)

Facilities management is a new field of study emerging within engineering as well as a new service sector that has been developing due to outsourcing of non core competencies such as cleaning and office management to third party providers. As a consequence there are many definitions and understandings of facilities management (e.g. Then, 1999; Nutt, 2000). One way to understand facilities management is to look at it as the integration of the organizational processes in order to maintain and develop the services supporting and improving the effectiveness of the primary processes (Jensen, 2008, p. 10). Another definition of facilities management frequently used describes FM as an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of that organization (Pathirage et al., 2008, p. 5). These views are implicitly based on the concept of the value chain that distinguishes the primary from the secondary activities of an organization (Porter, 1980).

Pathirage et al. (2008) argue that the FM literature (e.g. Amaratunga, 2001) identifies four generations of FM that focus on the changes to the management of facilities over the last few decades. In the first generation FM was considered as an overhead to the organization and was something that had to be managed for minimum cost rather than optimum value. In the second generation, FM took a process perspective and promoted the process focus between the organization's individual businesses and the FM organization by making FM activities within the organization a continuous process (Amaratunga, 2001 in Pathirage et al., 2008, p. 8). In the third generation, FM becomes more concerned with resource management, concentrating on managing supply chain issues associated with the FM functions. Finally the fourth generation focuses on the alignment between organizational structure, work processes and the enabling physical environment arguing that the organization's strategic intent must clearly reflect the facilities dimensions in its strategic business plans. This paper does not take into consideration such strict distinction and is mainly positioned in the third generation of FM according to Pathirage et al. (2008). These are however just background concepts for investigating and understanding the factors impacting ICT systems adoption in the FM supply chain. Therefore it can be that some factors affecting ICT adoption are more relevant at strategic level, others are more relevant at tactical and operational level, while some are important at all three levels.

2.2 Supply Chain Management (SCM)

The supply chain management concept has traditionally centered on the manufacturing industries (Zdisin et al., 2000) and according to Vandaele and Gemmel (2006) only a few studies have investigated SCM in the service industries (e.g. Ellram et al., 2004; Mabert and Venkataraman, 1998). However in services, and especially facilities services, SCM is becoming more and more important due trends such as outsourcing (Li et al, 2006). In services, SCM deals rather with customer-supplier dyadic relationships than with the unidirectional movement of physical goods (Fitzsimmons and Fitzsimmons, 2006; Sampson, 2000).

There are many definitions of supply chain and supply chain management. Christopher (2005) defines supply chain as a network of connected and interdependent organizations mutually and cooperatively working together to control, manage and improve the flow of materials and information from suppliers to end users (p.6). Supply chain management takes a systems view regarding all activities and functions that are needed to bring a product or service to market (Sanders, 2007). SCM can therefore be seen as the integration of business processes from end users through original suppliers to provide products, services and information that add value for customers (Cooper et al., 1997). This view of SCM is similar to the one provided by Christopher (2005) according to which SCM is the management of upstream and downstream relationships with supplier and customers to deliver superior customer value at less cost to the supply chain as a whole (p. 5). Akkermans et al. (1999) by conducting an extensive literature review of SCM conclude that it is possible to detect some common characteristics in the various SCM definitions. These common characteristics can be summarized as the involvement of multiple echelons, processes and functions like, for example, suppliers, purchasing, manufacturing, distribution, marketing, sales, and customers; a clear focus on the coordination and/or integration

mechanisms and the achievement of a simultaneous increase in customer service and profitability as major goal. In this study by applying Christopher's (2005) definition of supply chain to facilities management, I define the *facilities management supply chain as a network of connected and interdependent organizations mutually and cooperatively working together to control, manage and improve the flow of facilities management materials and information from service suppliers to end users*.
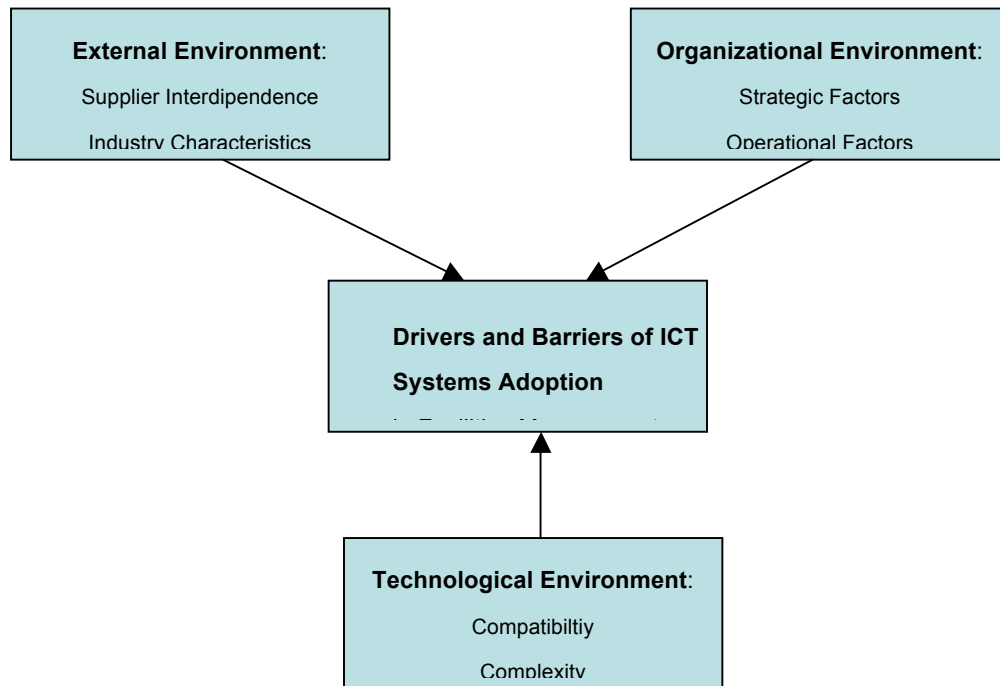
Companies involved in supply chains have introduced business-to-business ICT solutions to support their relationships that range from transactional exchanges to collaborative partnerships (Klein and Rai, 2009). Similarly, ICT use in the supply chain has been investigated from different perspectives. For example Klein and Rai (2009) focus on information flows in logistics supply chain relationships; Croom (2000) investigates the impact of Web-based procurement on the management of operating resources supply. Several studies have investigated ICT and supply chain in specific geographical areas or nations. Among these, Marchet et al. (2009) investigate ICT adoption in the supply chain of the Italian transportation industry; Mzoughi et al. (2008) investigate the impact of supply chain management and enterprise information systems (ERP) on organizational performance and competitive advantage in Tunesian companies; and finally Gallear et al. (2008) examine the uses, the perceived benefits, and future perspective of web-based technology in purchasing and supply chain in the UK. Their findings provide only limited evidence in support of the proposition that the deployment of web-based technology leads to stronger buyer-supplier relations. However, Gallear et al. (2008)'s findings suggest that the effectiveness of the purchasing and supply function can be enhanced through greater use of web-based technology for online purchasing and for efficient consumer response.

2.3   ICT Adoption

The innovation diffusion theory (e.g. Rogers, 1995) has been extensively used in studying technology adoption as well as in the identification of the factors that facilitate or inhibit technology adoption and implementation (e.g. Grover and Goslar, 1993; Ranganathan et al., 2004; Harrison and Waite, 2005; Ngai et al., 2004). According to Rogers (1983, p. 21), adoption is a decision to make full use of an innovation as the best course of action whereas rejection is a decision not to adopt an available innovation. In this study, adoption is defined as the decision to make use of FM ICT systems to conduct transaction with trading partners in the facility management supply chain. There are two levels of adoption. Initially, innovation must be purchased and adopted by an organisation. Subsequently, it must be accepted by the ultimate users in that organisation, community or supply chain also called implementation (Manross and Rice, 1986; Rogers, 1995). In this paper when I refer to adoption I refer to these two levels indistinctly. Several researchers have identified the factors or group of factors that affect IT adoption in an organization (e.g. Jeyaraj et al., 2006) and more recently and to a lesser extent in a supply chain context (Gallear et al. , 2008; Mzoughi et al., 2008; Meixell, 2006). Ranganathan et al. (2004) by conducting an extensive literature review identified 2 main groups of factors that affect IT adoption and diffusion in the supply chain: the external environment of the firm and the internal organizational environment. Ranganathan et al. (2004) expect that the three factors from the organizational environment (managerial IT knowledge, centralization, and formalization) are associated with internal assimilation of Web technologies and systems, while the three factors pertaining to the external environment (supplier interdependence, competitive intensity, and IT activity intensity) are associated with the external diffusion of Web technologies and systems in the supply chain. The importance of supply chain ICT adoption factors belonging to the organizational environment as well as to the external environment has been confirmed in other studies as well (e.g. Fichman, 2000; Johnson and Whang, 2002). However ICT adoption literature also found that the characteristics of the technology itself might be important in the adoption and diffusion process both at organizational (e.g. Rogers, 1995; Tornatzky and Fleischer, 1990) and supply chain level (Gallear et al, 2008). For example in a study of adoption of mobile technology in the supply chain, Doolin and Ali (2008) found that three key attributes of the technology have an impact on its adoption: relative advantage, compatibility and complexity. Finally, Croom (2000) by investigating the impact of web-based procurement on the management of operating resources supply, which can be considered as a subset of facility management services, finds two broad classes of drivers influencing

e-procurement adoption: "operational" and "strategic". The operational drivers include for example the ability to reduce administrative costs of the whole procurement process, while strategic drivers include for example greater influence and control over expenditures by the procurement function.

By drawing on the previous literature review, the following model of factors influencing ICT adoption in the supply chain of facilities management is proposed in this paper:

External Environment:

Supplier Interdipendence

Industry Characteristics

Organizational Environment:

Strategic Factors

Operational Factors

Drivers and Barriers of ICT Systems Adoption

Technological Environment:

Compatibiltiy

Complexity

Fig.1: *A model of factors influencing ICT adoption in the supply chain of facilities management*

This model includes and groups the main factors that influence ICT adoption in the supply chain into three main categories (external environment, organizational environment, technological environment) and is used in a qualitative way to guide the data collection and the analysis of the data. In addition this model has the purpose of theoretically addressing the research gap: namely a comprehensive model of factors affecting ICT adoption in the supply chain of facilities management.

3 RESEARCH METHOD

In order to investigate the research question a qualitative research method has been adopted. Data for the study were gathered from archival sources, interviews with companies as well as attendance to practitioner conferences and workshops on the topic of IT systems, innovation and partnerships in facilities management. The conferences and workshops contributed mainly to understand facility management, the Danish facility management sector, the issues of relevance to ICT adoption in this sector and to make relevant contacts for the interviews. In all, representatives from twelve organizations were interviewed. A mix of FM service providers, FM customers and FM ICT system providers was chosen to help reveal differing factors affecting the adoption of ICT systems in facilities management supply chain. Software vendors and providers have been selected as it is believed that they have a good insight about the factors that influence ICT adoption both in the service provider and the customer. All respondents were involved with the adoption, development and use of ICT systems in facilities management supply chain in their company and had a high level position in their company. Confidentiality of the study data was necessary due to commercial sensitivity perceived by most of the respondents. All interviews were conducted in the period December 2008-March 2009, and each lasted circa 1.5-2 hours. Interview questions were semi structured (Yin, 2003) attempting to elicit the variety of factors that affect adoption of supply chain management ICT systems in both FM

providers and customers. All interviews were tape-recorded and transcribed. Notes were also taken during the interviews. To increase reliability an interview protocol was developed based on the research model prior to the interviews (Yin, 2003). This protocol was slightly adjusted depending on the type of company interviewed: FM providers, FM customers or ICT system providers. The protocol questions were organized into two parts. The first captured company background information such as type of business, years in business, facilities management activities and use of ICT in facilities management. This information were supplemented by information provided on the companies' web site, annual reports, sales brochures and other material provided by the companies or collected in the practitioner workshop and conferences where the author participated. The second part specifically aimed at collecting information about the significant factors affecting adoption of ICT systems in the facilities management supply chain. Even though I do not provide company details here for space constraints, the companies interviewed are referred to as A1-A12 to make the analysis clearer.

4 ANALYSIS AND RESULTS

4.1 Organizational Environment: Strategic and Operational Drivers and Barriers

The study reveals that there are a number of organizational drivers and barriers both at strategic and operational level that influence ICT systems adoption in FM supply chain management, summarized in Table 1 and 2 respectively. The study also finds that while the drivers are both of strategic and operational nature, the barriers are mainly found at operational level.

4.1.1 Strategic Drivers

The decision to outsource facilities management activities to external service providers has created new challenges regarding the company's FM knowledge, especially since the FM external service providers could potentially change periodically due to the limited time procurement contracts. Therefore the outsourcing decision has been a major strategic driver of adoption of ICT systems in FM supply chain. The ICT system, in fact, can centralize FM knowledge in one place where it can be accessed both by the service provider and the service customer (A7). Company growth influences the ICT adoption decision, therefore company growth is seen here as a strategic organizational driver. This is because as the company grows there is the need to centralize the FM information in one place to make it easier for employees to access FM related information in order to make the right decisions (A7). In addition company size also influences ICT adoption. For example the establishment of a FM help desk is seen as a good solution to immediate FM service response, but it can only be justified by the size of the company (e.g. A5). Return on investment and increased efficiency are also key strategic factors influencing the adoption decision (A4). A big importance for adoption, especially in the implementation phase (see sec. 3.3.) has also the ICT policy used by the company (e.g. A3). Therefore if the adoption decision is made centrally and enforced by top management then the ICT systems might be adopted and used in a more satisfying way then situations where the decision is left to other employees or managers of the company (A3).

4.1.2 Operational Drivers

Important operational organizational drivers of ICT adoption in FM supply chain include better overview of the activities and the budget. For example a manager of an FM service provider (A1) mentions how ICT FM systems have helped them both to be more systematic in conducting their work and to manage and make better service decisions, thus in general providing a competitive advantage and added value to the company. Similarly A3 and A7 points out how the wishes to have a better overview of the FM budget and FM activities have been important operational drivers of FM ICT systems adoption (e.g. A3, A7).

Table 1: Organizational Drivers

Strategic Organizational Drivers	Operational Organizational Drivers
• Better strategic and tactic FM management decisions (A1) • Better long and short term planning and forecasting of FM resources (A7) • Company policy (A8) • Return on investment and improved efficiency (A4) • Outsourcing of FM services to third party providers (A7) • Company Growth and size (A7)	• Better overview and control over the budget and the activities to be done (A3, A6, A5, A8) • Faster service delivery and response to help situations (A1, A9) • Overview of the buildings by making it visual (e.g. 3D) (A6, A8) • Better working conditions by having all the info in one place (A6; A7) • Being closer to the clients and the users of services through direct communication (A4) • Improved quality assurance of the service delivered (A7) • Cost Transparency (A5) and capability to link costs to each activity (A5)

Another major operational adoption driver is better communication between the supplier and the customer, making service providers and service customers feel closer to each other as well as making it easier to go by gatekeeper employees and communicate directly with the relevant people (e.g. A4). For example FM service providers can get a better and quicker overview of the situation at the customer site and consequently might be able to provide a better service (e.g. A1, A4, A3). This is especially possible when the FM ICT system has a help desk function, allowing for the customer to immediately inform the provider of needed help and the provider to see and react promptly.

4.1.3 Strategic and Operational Barriers

The major strategic organizational barrier found in the study is the lack of resources made available by the company to learn how to use the FM system *(e.g. A6)*.

Several operational barriers were instead found, summarized in Table 2. For example, one important operational barrier to ICT FM systems adoption is that usually at the point of construction the building owner does not know what he/she would like from FM after the building is completed. Therefore they underestimate FM and the data collection process related to it. This, instead, should already take place at the stage of planning and construction of a building as a construction consultant in a big consulting institution (A6) has pointed out.

Table 2: *Organizational Barriers*

Organizational Strategic Barriers	Organizational Operational Barriers
• Lack of resources to implement the ICT system and to make the necessary organizational changes in order for the system to get implemented and used (A2, A6, A9, A10)	• Employees resistance to change at the operational level (A1, A2, A6, A7, A9, A10) • Lack of IT competence (A1, A2, A6, A7, A8, A9, A10) • Building owners do not know what to ask from FM in the construction phase (A6, A7, A8) • Lack of language skills (e.g. English) (A5, A9) • Difficulty to incorporate in the service contract the process of how to get data from the service providers (A7)

As discussed in the adoption drivers, the ICT systems offer many advantages and opportunities to be accurate and stringent with the FM data. On the other hand such accuracy and standardization of FM data required by the ICT systems is also perceived to be a barrier to adoption (A7) at operational level.

Other adoption barriers include the employees' lack of competences that can be either related to ICT use or to the use of English language. This is the case especially for employees using the system at operational level *(A5),* (e.g. plumbers*,* cleaners, etc.*)* since they may not be familiar with the English language, which is the language normally used by the ICT system, or may not be ICT literate.

4.2   Technological Environment

The study shows that there is a number of technology related drivers and barriers that influence adoption of FM ICT systems in the supply chain as showed in Table 3. As discussed in the theoretical part, these characteristics are found to be mainly related to the complexity and compatibility of the systems.

4.2.1   Drivers

The study found that important technology drivers are better integration between the suppliers' and the providers' data as well as improved control and systematization in the data collection. In addition the possibility to visualize the data as well as have intelligent buildings could be important drivers in the future *(e.g. A6).*

4.2.2   Barriers

A major technology related barrier is found in the complexity of the ICT systems used in the FM supply chain. In their daily use, these system are found to be too complex and not user friendly. Another barrier lies in constant updating of the data that these systems require. In fact if this is not done in a very systematic and stringent way, then the data might not be valid and the decisions might be taken on a wrong basis as pointed out by for example by the Director of the Facilities Management Department of Big Consulting Company in the Building and Facilities Management Market (A3).

Table 3: *Technological Drivers and Barriers*

Technology-related Drivers	Technology-related Barriers
Increased control and systematization in data collection (A1, A7, A8, A10) Visualization of the data (A3, A6) Possibility of Intelligent Buildings (A3, A6)	The ICT systems are too complex to use (A2, A6, A5, A8, A9, A10) Continuous updating and inserting the information in the system (A3, A8) Lack of standard format and classification schemes for FM data (A6, A7, A8, A9, A10) Incompatibility of different systems, implying a lot of re-keying if it is necessary to change the system (A5, A8) Releases of updated software versions making it more complicated to learn to use the system (A6)

Other major barriers are the lack of classification schemes and standard formats to represent the data to be inserted into the facilities management ICT system. A final barrier is the incompatibility of different systems, implying a lot of re-keying if it is necessary to change the system (A5, A8) or to move the data from one system to another within the same organization.

4.3   External Environment

4.3.1   Drivers

The study found a number of important external drivers and barriers summarized in Table 4. For example, this study found that supplier interdependence is a very important driver of ICT adoption in the supply chain of facilities management (e.g. A1, A2, A4). Suppliers' or customers' suggestions, requirements or pressures, in fact, influence ICT adoption in the facilities management supply chain. Sometimes the adoption is a prerequisite for conducting business together and therefore mandatory

(e.g. A4, A12), sometimes it is a suggestion that might lead or not to the adoption of that specific system. This depends on the specific facilities management activity that has to be done, the specific contract the customer and the supplier engage in and, especially, the power relationship between the two companies engaging in a supply chain relationship (e.g. A3; A2, A10). For example the customer may require a single point of contact with the service provider and if the services provided are many or complicated, this task is impossible to be handled by only one person, so the single point of contact becomes the ICT FM system (e.g. A4). In this case the ICT system might be vital for the existence of the service provider and for the relationship between the service provider and the customer.

Another important factor is related to the FM industry characteristics. Especially in periods of high industry growth this can be an important external driver (A7) as this might be the reason for the job market flexibility, implying high turnover of employees. Therefore the need to keep the information and knowledge of the employees in central FM ICT systems (e.g. A3). Finally the study found that state policy might also be a driver of adoption. For example in Denmark the state requirement that all the building projects above circa half a million dollars have to conduct all the project related paperwork electronically (digital construction initiative) is seen by the respondents of the study as a factor that might drive adoption of FM ICT systems in the future.

Table 4: External Drivers and Inhibitors

External Drivers	External Barriers
• Supplier Interdependence-FM provider or customer (in an outsourcing situation) are forced to accept the partners' system or clients may ask for single point of contact (A7, A4, ,A3, A12) • Industry Characteristics :Job market flexibility (A7) • State Policy (e.g. the digital construction (A7, A9))	• Lack of collaboration among software providers, building owner and users in developing ICT systems (A6) • Industry Regulation (validation)(A5) • Sub-suppliers not knowing Danish if they are Germans or Polish (A9) • Disagreement between the service provider and the customer about the data needed to be delivered (A8)

4.3.2 Barriers

One major external barrier identified in the study is the lack of collaboration among software providers, building owners and users in developing ICT systems (e.g. A6). In addition, while supplier interdependence is an important driver, an important issue is coordinating and formally righting in the contracts between supplier and customer when and in which format the data need to be delivered, which can be often a barrier to the effective utilization of the system.

Industry regulation might also be a barrier at times. For example A5 had a web-based system that was not validated by some regulatory bodies and therefore they had to switch to an enterprise resource planning (ERP) system which was not web-based. This implies that a lot of data have to be typed manually into the system on a daily base, with a lot of double work and possibility for mistakes.

4.4 Discussion

One major finding of the study is that outsourcing of facility management services and related issues have been the main drivers of adoption of ICT in the supply chain of facilities management in Denmark. Other studies have focused on the relationship between outsourcing and ICT, but they have mainly taken the re-engineering perspective (e.g. Davenport, 1992) therefore focussing on ICT as enabler of organizational innovation and outsourcing (e.g. Abramovsky and Griffith, 2009). In this study I found that companies first might outsource FM services and then they realize that ICT is instrumental for this supply chain relationship to function. For example, companies outsourcing facility management services to outside providers find suddenly the need to adopt ICT systems in order to keep in house the knowledge (or at least a copy of it) related to their facility management operations. Such knowledge, otherwise, would be located only at the service provider site with the risk of loosing it completely due to the limited time procurement contracts. Other factors such as supplier

interdependence, better communication or better service provisions are also a consequence of the outsourcing decision. Also other issues within the external environment such as supplier interdependence or formalization of the data delivery process among the supplier and the customer are mainly related to the outsourcing decision. However, the study also find a number of internal organizational factors impacting ICT adoption in the FM supply chain related to the fact that facility management as a support activity (e.g. Porter, 1980) is getting momentum in organizations as also showed by Jensen (2008). These factors include for example better FM related strategic and operational decision making. Finally some factors are related to the technology itself and these are the ones most frequently found in the literature such as complexity and compatibility (e.g. Doolin and Ali, 2008). Another major finding of the study is that some factors can be either drivers or barriers depending on the context they are considered in or the organizational level (strategic vs. operational) they are looked upon. For example, while having all the FM data in an ICT system might be driven by the need to make better strategic and tactic FM management decisions this might be a barrier for the employees at the operative level since they have to change their routines and be stringent and consequent in their FM data collection and recording.

5 CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This article has presented the results of a study of factors impacting information and communication technology (ICT) adoption in the supply chain of facilities management in Denmark. The study has showed that ICT systems in facilities management supply chain are starting being adopted and used by companies. This is driven by a number of adoption drivers, however many barriers are still preventing the best utilization of the systems. Major adoption barriers are the characteristics of the ICT systems, since they are not user friendly and often are incompatible with each other, the lack of standards and classification schemes for inputting the data into the system as well as the lack of knowledge and awareness of the building owner about what they want from facilities management after the building has been built. The study shows that there are a number of important external drivers of ICT systems adoption among which company interdependence, market flexibility and government regulation. The study also found a number of organizational drivers and barriers of ICT adoption. Among the drivers there are better FM management decisions, better long term and short term planning and forecasting of FM services and resources, better overview and control over the budget. Key barriers include the difficulty of righting in the service contract the process of how and when to get data from the FM service providers and lack of resources to implement the ICT systems.

This study has important implications for operation managers and ICT systems developers. ICT systems developers should try to improve such FM systems to make them more user-friendly and especially find an easy way to categorize and standardize the different facilities elements and components. On the other hand facilities managers and FM organizations should be aware of the advantages brought by such systems, not only for internal efficiency and customer-supplier relationships, but also for keeping the facilities services knowledge in house especially when FM is outsourced.

The study, however, is not free of limitations. For example it is difficult to generalize from this data set as the number of interviews is very limited. In a second phase of the research, the author intends to use these qualitative results to conduct a comprehensive survey of factors affecting IT adoption in the FM supply chain in Denmark to further test these qualitative results. This research design has been successfully employed in other studies (Chong and Bauer, 2000). Alternatively in further research a case study could also be conducted to go in depth in one company with the analysis of drivers and barriers of ICT adoption in facilities management supply chain. Finally, this study provides some useful insights into factors impacting ICT adoption in the supply chain of facility management services. Further research could for example investigate whether these results are also found in other service industries as well.

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