

Critical Skills and Knowledge in Development of e-commerce Infrastructure

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Abstract— *In general, information systems development is based on existing systems. This is also the case with information technology infrastructure (IT infrastructure) because all earlier development work and decisions impact the reliability and flexibility of the infrastructure. This makes management of IT infrastructure development an important challenge.*

Information systems rely on infrastructure in sharing data and information. Here we focus on IT infrastructure and discuss what skills and knowledge is needed in development of e-commerce infrastructure for the company. We argue that the skills and knowledge of persons involved in the development process is a critical resource.

Index Terms— *development, e-commerce, information technology, infrastructure, knowledge, skills*

1. INTRODUCTION

IN this paper we focus on information technology infrastructure (IT infrastructure) and discuss its role in the company. The question here is that what skills and knowledge is needed in developing a robust and flexible IT infrastructure for e-commerce purposes.

Investments in information technology are often considerable and they impact the organization in many ways [1]. In information systems development it is important to identify the key technologies and solutions, otherwise investments may soon become obsolete. Furthermore, expertise and knowledge in information technology is needed in developing services for business purposes.

Open discussion and interaction is important, they are needed in the development group so that the goals become clear to all who are involved. Consequently, understanding what technology can do and what benefits it brings in the company is a key issue [2].

2. IMPORTANCE OF IT INFRASTRUCTURE

Information technology infrastructure is the basis of other systems that are used in the organization. It is the enabling platform that connects users and their workstation to common resources [3], [4], [1]. IT infrastructure also connects different locations and is the route to other networks (e.g. Internet) and to business partners and their IT infrastructure.

Information technology infrastructure can be divided into two components, the technical IT infrastructure and a human IT infrastructure [5]. Here the technical IT infrastructure is company's technology and information that is intended to be shared [6]. Technical IT infrastructure is more than different computers, hardware devices and components. It also includes common applications, data and practices in processing information [7].

Because information technology infrastructure consists of both hardware and software components it – IT infrastructure - can be defined also differently. Another definition of IT infrastructure divides it into three elements [3], [8], [9]: Firstly, there is a technical element. It refers to hardware like workstations, servers and devices that are needed to connect computers together. Secondly, shared services are an element that includes software components. For example, common mail system or databases that are used by different business

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applications and users across the organization are shared services and part of the IT infrastructure.

Information technology infrastructure includes also a human dimension. IT skills, expertise, management practices, competencies and commitment - the human IT infrastructure – is even more important than technical issues [5]. The human element binds technical components into IT infrastructure services that are shared in business processes. This viewpoint highlights the importance of human element in information technology management [Error! Bookmark not defined.], [9], [8], [1].

3. FLEXIBILITY OF THE IT INFRASTRUCTURE

Existing infrastructure and information system sets the guidelines for the IT infrastructure development process. Therefore, openness of the infrastructure is a key feature. Openness refers here to the ability to fit components from different manufacturers together, but it also means that different systems and processes can be integrated [4], [1]. Also standards and standards compliance is needed in IT infrastructure development. Without them it would be difficult and expensive to make different infrastructures and systems that interconnect. These issues are important also in development of e-commerce infrastructure.

The flexibility of the infrastructure is an important issue [10]. McGarty [11] points out that it must be possible to expand and modify the IT infrastructure when requirements change. Especially in e-commerce applications the system is expected to be almost infinitely scalable: for example, the amount of potential customers in the e-commerce site can increase rapidly, and therefore it should be easy to add processing power and capacity. The bandwidth and security are also important issues, especially if the site is inside company's local area network. The e-commerce infrastructure must also support interfaces to different partner's infrastructures. For example banks and companies in logistics may need to be interconnected.

4. TAXONOMY OF SKILLS AND KNOWLEDGE IN IT MANAGEMENT

In general, skill relates to a capability to do something concrete, whereas knowledge refers to abstract reasoning [12]. What are skills and knowledge in information technology management? In maintenance activities are both concrete skills and abstract thinking needed. For example, troubleshooting involves finding the problem (abstract thinking) and then fixing it (concrete skills involved). Furthermore, reliability of the infrastructure is based on careful maintenance and disaster planning – there is a need to protect the system against viruses, intruders etc. The level of skills and knowledge in maintenance materializes in the robustness and reliability of the information system. This is also called as the “trustworthiness” of the information system in the organization [13].

IT related skills, knowledge and experience are also critical when new information systems and services are being developed for business purposes. This is an area where the most significant business capabilities and value can be created [3]. Support from top management is needed – and this does not refer to money alone. It is vital that the business strategies and IT development activities are interconnected. As noted by McKay and Brockway [3], information technology brings added value to business only if it supports business needs and is managed by skilled IT people.

Development of information systems is a challenging task because many systems impact the organization deeply. They are shared among users that work in different departments and geographical locations.

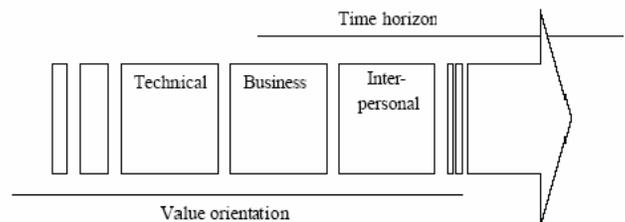


Figure 1: Domains of skills and knowledge

Furthermore, information systems can be available across several companies and industries. Therefore the role of IT

management is critical in development of systems and services that meet the needs of users and create value to operations [3], [4]. Here technical skills and knowledge alone are not enough.

In general, people who are involved in IT development should possess skills and knowledge in a wide area [14]. These can be divided into three main domains: technical, business and interpersonal skills and knowledge [15], [16]. Feeny and Willcocks [17] have found two more perspectives, value orientation and time horizon (Figure 1).

The human element, knowledge and skills of people involved in IT development is considered as a critical success factor in information technology development and use [2], [15], [5]. We argue that this is also the case in development of e-commerce infrastructure.

4.1. Technical skills

It is evident that technical understanding is required in IT development. There is a need for both detailed technical knowledge in the technology in question and also a broader understanding that covers the areas that the technology will affect is needed. Technical knowledge is important, and if company's own expertise is weak it is a good idea to look for outside advice. For example, using a consultant in security planning may be a valuable investment.

Technical skills should not only be seen as limited technical knowledge like knowledge of technical devices, solutions and alternatives. There is also an interpersonal dimension involved as development alternatives and possibilities are often mapped during discussions with outside experts and vendors. Technical knowledge, interpersonal skills and experience are needed to judge a technology, product and a solution. Understanding the technological capability can also be important in monitoring partner and vendor relationships. Here previous experiences of a technology or a partner are in an important role.

It is important to notice that technical knowledge and expertise is needed at all managerial levels that are involved [5].

Making decisions that have critical operative importance today and affect future development calls for understanding of the technology and the system that is being developed – all who are involved in the development process should mutually understand the key questions and concerns. This is possible if the persons have reached a “know why” stage and are therefore able to use the same language, interact and understand the development area and challenges that are involved.

4.2. Business skills

Information technology is used in business processes, and it makes it possible to achieve strategic goals of the organizations. Therefore business understanding is critical in IT development. This is also the case in development of e-commerce platform.

Business understanding is often linked to leadership, business systems thinking, relationship building, informed buying and vendor development [17]. These skills and capabilities are important in information technology management as well [18], [15], [5]. As Feeny and Willcocks [17] write:

“IS professionals deliver core IS capabilities by exploiting assets that previously enabled their successful IS careers: rapidly absorbing new information, building mental models of how things work, and using these models for exploration.”

The importance of business understanding in IT development is clear. It could even be argued that IT development requires so many business skills, that business people and managers should develop information systems instead of IT people. Nevertheless, IT people with technical expertise are also needed – but also people with business understanding must be involved in IT development.

4.3. Interpersonal skills

In general, interpersonal skills are important in IT development. Information technology development is based on cooperation and mutual understanding between the people who are involved in development work. Interpersonal skills are at stake in both internal and external relationships and interaction.

People in the IT department should have good interpersonal skills so that others in the organization could understand them – technical jargon should be avoided. Narrow technical orientation may lead to misunderstandings and problems in the development work. IT people should also understand business requirements, processes and the needs of the users. Furthermore, IT people need to convince the business people that information technology helps in achieving business goals.

Interpersonal skills are needed also in external relationships. For example, working with outside service providers calls for interpersonal skills. Interpersonal skills are especially critical when showing business partners that their values, goals and problems are respected and understood.

4.4. Value and time Horizon

Information technology involves large investments in technology that may be used only to a given purpose [14]. However, developers should build systems that are robust and operate reliably for a long time [4], [19]. The systems should also be flexible so that future expansions and change in needs can be incorporated [10]. This highlights the importance of development of a system that serves as a basis for operations, but still is open for modifications. The need for an IS-strategy is obvious – it helps in operative decisions and brings a longer time perspective to IT development.

How should skills and knowledge in IT infrastructure development reflect these requirements? Obviously, some skills are more oriented to short-term interests than others. In technical maintenance the perspective is short as the goal is to solve a problem as soon as possible. Therefore the system should be build so that it is easy to locate and solve problems when they occur. Weaknesses and bottlenecks should be mapped and alternative recovery plans need to be done in order to increase the reliability and robustness of the system. This mapping calls for skills in finding solutions to various potential technical problems.

However, a longer time perspective is important in development. Business thinking, architecture planning, vendor development and contract monitoring have

their emphasis on long-term positioning. The same long-term interest can be seen in developing business processes that support strategic goals, or planning technical architecture that is open and flexible in the future.

4.5. Interplay of different types of skills and expertise

The role of different skills and knowledge is empirically studied in interviews in six organizations. We interviewed top managers and IT managers in organizations from different industries in order to understand of the interplay of different skills and expertise in various stages of development of e-business infrastructure. As noted above, there are three types of skills and expertise – technical, business and interpersonal - needed in IT development. These skills and expertise are interdependent, even though they are different [20]. For example, people with a business background consider IT people competent not only on the basis of their technical expertise but they are also judged based on their business understanding and interpersonal skills. On the other hand, systems development is more successful if business people understand how technology can be applied. Here interaction with IT people and finding a “common language” are the key to success. Continuous discussion is also needed with other persons involved in the development work. This helps other stakeholders in understanding their role as in the puzzle one interviewed manager told.

Interaction is a critical element in information technology development [20]: the more there is discussion and cooperation, the stronger the mutual understanding will become. Here interpersonal skills are in a key role.

Even though technical expertise and business understanding are needed, discussion and interaction are needed to develop mutual understanding of the development goals.

The results of mutual understanding will materialize in better planning of new systems and more sophisticated use of existing information technology.

3. DEVELOPMENT OF THE E-COMMERCE INFRASTRUCTURE

In general, information system development is defined as developing a system that meets needs or improving the existing system [21]. The development process involves organization of the process, mapping of the organization, mapping of the present state of information processing and the actual design process [22], [21]. Here we apply these stages into development of e-commerce infrastructure.

Once the need for moving towards e-commerce is identified the development process must be organized and a development group must be formed. Members of the group are often picked based on the skills, role and interest that

alternatives and make design choices. Also business understanding is vital as noted by interviewed business managers.

In development work can outside sources of information be valuable. These may include advice from consultants, academic people or experts. Also conferences, professional journals and other e-commerce sites can give ideas.

The second stage in the development work is mapping the organization. This refers to developing a mutual understanding of the key sectors of operations, how the information flows from one department and person to others etc. It is vital to have business understanding because e-commerce should be integrated to business processes. Obviously, business expertise and interactive skills are critical at this point.

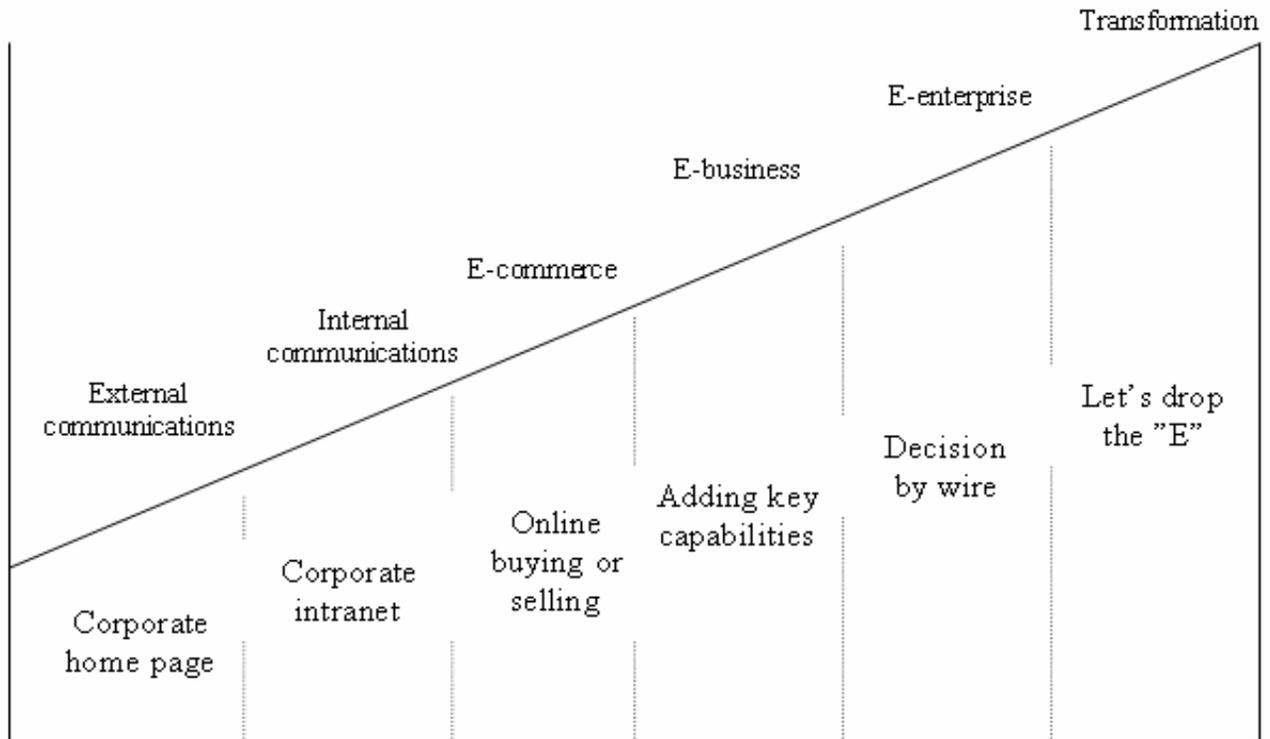


Figure 2: Evolving the e-enterprise (Earl, 2000)

they have towards the e-commerce platform. Here business knowledge and interactive skills are at stake. A typical development group could include IT people, business managers and other key people, users and outside consultants. The important issue is that the development group has enough expertise in order to evaluate different

Mapping the present state of information systems refers to existing information system: the development group needs to understand what the underlying infrastructure is. For example, e-commerce applications are often linked to existing databases and financial systems. This is why new technology should fit into the

existing IT infrastructure [23], [10]. Building a robust and reliable system that integrates existing systems with new technologies is a challenge for the development group. Therefore the actual design process calls for technical expertise.

The development of an e-commerce infrastructure takes a long time. It involves also other than technical issues, for example identifying potential products and customers for e-commerce. Typically, the development of e-commerce is an evolutionary process of moving traditional business into e-business [24]. The other alternative is that company builds operations to Internet alone. In both cases there are several stages involved in the process (Figure 2). As Earl [25] notes "lessons learned in each stage and where each stage leaves behind critical imperatives for the next one".

In first two stages the main emphasis is often on external or internal communication. Possible applications range from company's home pages to extranets that connect business partners to company's information systems. In these stages learning how IT can be applied has an important role. It involves skills and knowledge in technology (web-technology, security etc.), business understanding (importance of up-to-date content on the home page etc.) and interactive skills (organizing the development work, involving technical experts, business people and outside service providers etc.).

The next two stages are about selling or buying online. The key challenges here are connected to promoting e-commerce, selecting and pricing products for e-commerce and managing brand. On a deeper level e-commerce and e-business involves positioning e-activities with traditional business and redesigning business processes [26]. These challenges require mostly business expertise and understanding of what are the strategic goals of e-commerce related activities in the company.

E-commerce makes it possible to collect and use data of all online transactions. It allows decision-making that is based on real-time information.

Therefore, management processes should be redesigned so up-to-date information can be used in company management. This can introduce new ideas of management control, thus being the basis for institutionalizing the online business model [24].

Another interesting framework of e-commerce positioning and development is a awareness/positioning framework (or commitment-implementation matrix) proposed by Stroud [27]. It is based on two questions: firstly, what is the managements' vision of the relative importance of technology. Secondly, how can Internet be integrated into existing organizational structures.

Based on these questions company's level of commitment ranges from wait and see –approach to business innovation where processes are redesigned so that the potential of Internet can be used maximally. Similarly, the mode of development varies from building separate applications to business centric development where the potential of Internet is understood [27].

The interplay of technical and business understanding is a key issue in this framework. If company lacks technical expertise, opportunities may be lost as technology is not utilized. It is also possible that the importance of technology is diminished, left to technical people alone and not considered worthy of management's time and effort [27], [28]. The solution to these problems is in interaction between technical people and less-technically oriented business people.

In general, interaction is recognized as one of the primary requirements for successful information systems development and implementation [29]. Open discussion and changing opinions are critical for the development work.

However, there are also other factors such as personal characteristics of the group members and rewarding methods that affect the interaction and performance of the development group. Consequently, enhancing group interaction and discussion are important, but may not automatically ensure better results.

4. DISCUSSION

Development of e-commerce infrastructure – and information technology development in general - is more than making right technological choices. Managing the development process is a challenge, it requires business understanding in how technology can be utilized in the best possible way. The company's e-commerce platform and its role changes as the company integrates e-commerce into business processes [27], [25], [24]. Therefore e-commerce infrastructure involves continuous development.

The information technology infrastructure should be flexible so that it would be possible to modify it based on changes in environment and business needs. Despite this an organization's basic IT infrastructure is relatively stable over time [1]. Applications and information technology in business processes change more frequently because business processes need to be modified to meet customer needs, or as a response to changes in the competitive environment. For example, the e-commerce platform must be flexible in order to adapt to changes in business processes.

In general, technology is converted into IT infrastructure services through skills, knowledge and experience of people in the organization [8]. Ultimately, the value of information technology infrastructure depends on how effectively technical IT infrastructure can be converted into productive outputs [5]. The knowledge and skills of people who are developing new systems and services is considered as a critical success factor in information technology development [2], [15], [5]. Here we argue that technical, business and interactive skills and knowledge are important in information technology infrastructure development. Expertise from all three domains must be present in successful IT development activities. This is also the case in development of e-commerce infrastructure.

The relative importance of skills and knowledge varies depending on the development stage of the e-commerce platform. Interactive and business skills are

critical in the first steps of the development process when the project group is about to be formulated and the group members develop a mutual understanding of the development goals. Technical expertise is needed when different technologies are evaluated and the infrastructure is being planned. However, in later stages operations may increasingly rely on Internet, and company's whole business is built around e-commerce. Consequently, the importance of business understanding will increase when a company gets more committed to e-commerce [27], [25].

Ultimately, information technology needs to support organizational goals and therefore the role of ecommerce must be discussed. Discussions are important for understanding the potential of e-commerce and information technology in the company. Open discussion and interaction are the basis for development of a flexible e-commerce infrastructure that serves business goals.

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