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Integration in Information Systems Management

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***Abstract*— Information systems management is challenged to deliver robust and reliable solutions that make business activities possible on a daily basis. at the same time systems and infrastructures should support achieving strategic goals. Information technology is expected to be flexible even in turbulent environments, making it possible to rapidly create new business and take advantage of business opportunities in the best possible way. Clearly, this is a significant challenge for information systems management, and calls for understanding of business goals, strategies, and the capabilities that information systems potentially provide.**

Overall, information systems management is a challenge which is often connected to integration of business and technology in the organization. Business managers are seldom technology experts, and vice versa. Accordingly, there is a need for understanding what technology, infrastructure and information systems in the organization can do to support business goals. On the other hand, information technology experts should be better aware of operative and strategic business goals.

In this article we study the management of information systems and technology. Here integration of operative and business activities with technology is needed. There are also other viewpoints to integration, it is about integrating heterogeneous technologies and systems together. Furthermore, different applications and systems are often provided by different organizations, which gives an additional perspective to management of information systems integration.

***Keywords*—information systems, integration, infrastructure, technology, modularity, flexibility**

I. Introduction

Information systems are in a key role in practically all companies and organizations. Even minor problems with information systems, such as a malfunction in sales system can cause a significant impact on operations. Therefore, reliability and robustness are considered critical in information systems and information systems infrastructure [1]. Providing reliable systems for the organization and it's operations is a key task for the information technology developers. Another important issue is that technologies, applications and infrastructures should be flexible and open for changes in the future. Providing systems that enable rather than restrict is important, and makes it possible to survive in a changing environment.

In this article we discuss the importance of integration in information systems management. It is connected to applying technology in a way that enables meeting business goals and targets. On the other hand, integration is also about bringing together different applications, systems and technologies and make them work in a changing environment. Information systems management is more than organizing internal resources, systems and people together. As an example, there are external several systems providers, operators and experts involved in providing information system services for the organization.

II. Understanding Infrastructures, Technologies and Systems

Information systems are based on technologies that enable organization's daily operations and activities. The infrastructure refers to systems and technologies that form the platform for various applications [2], [3], [4], [5], [6], [7]. Here the term infrastructure refers to systems and technologies that are shared amongst users in different organizational units and functions for a variety of purposes. Infrastructures are also built to last for years, and therefore they should be flexible enough to serve changing organizational, functional and business needs. In most organizations technologies, computers, applications and information systems form the infrastructure which business operations and activities depend on.

Information systems infrastructures have several key features [4], [6]. To start with, they are sustainable meaning that infrastructures are built to last for a long time, and serve the organization as a backbone of business operations. Infrastructures reach departments, functions and users widely across the organization, extending far beyond a single place, process or event.

Standards and standards compliance are an important part of infrastructure. Standards make it possible to expand the system in the future and connect it to other infrastructures, also to infrastructures of other organizations. This is quite important because there are likely to be changes in the future, in areas such as technologies, organizational needs and competitive environment. Without standards and standards compliance it would not be possible to create infrastructures that are long lasting, and at the same time flexible to changes. However, even if technologies and systems would be standardized there are often several competing technologies and systems. Information systems management is therefore faced with choosing "right" standards, as even if the systems would follow standard it might end with a situation where some other competing standard wins and others disappear.

The development of infrastructures takes time and it happens gradually. Things do not happen overnight, in real life new technologies and systems are added to existing infrastructures. This means that they are built and based on existing systems, and also depend on strengths and limitations of existing technologies and infrastructures.

Modularity is an important issue in infrastructures. It is based on standards and standard compliance, they allow changes in technology, in individual components and systems. Standards guarantee interoperability of technologies and systems from different providers and manufacturers. Changes in organization and it's environment require changes in infrastructure. Here modularity is a key issue, it makes it possible to add new technologies and applications without significant changes in other parts of the system. Infrastructure acts as a backbone which makes it possible to add, change and remove individual components or modules in a way that there is no impact on the infrastructure itself or other modules in the system. As a result, modularity is an important design factor, without modularity changes would be time consuming, expensive and because of massive changes and resource requirements even impossible in real life.

Infrastructures are organization-specific [8]. They are shaped by organizations, their needs and practices. Infrastructure is deeply embedded in the organization, not only to existing base of technologies abut also in organizational and social structures in the company where the infrastructure is. Even though basic technologies may be common the infrastructures in organizations differ, systems and applications are used heterogeneously because of different practices in each function, team, group of users or even individuals and their needs. Consequently, technologies and systems cannot directly be copied from one company to another, for example [3].

Systems and technologies of the organization, and how they are used and applied are learned as part of the working process – they are learned as part of the membership of the organization. New staff members learn how to work in the company, and they also learn how information systems are being used in the work. There can be significant differences in how systems are used. For example, data can be stored differently into fields of a database in each organization, even though the systems are seemingly similar to an outside person. This can be result of inadequate training, or simply different practices in organizations. The result is however, that if people change jobs, move to other units or departments, or change the organization altogether they may notice differences in the way systems are used, and have to learn how to use the systems accordingly. Another result of using systems differently is that it can be almost impossible to integrate or consolidate systems from different organizations because of how data has been recorded differently into the systems.

Ideally, information systems and infrastructures are transparent to their users. This is the case when they are running and operating normally. Transparency is rapidly lost if there should be interruptions, slow connections or other operational issues in the infrastructure. As a result, technology and systems become visible upon breakdown. Smoothly operating information technology is a combination of several factors, and information systems management and maintenance are here in a major role [1]. Capacity planning, disaster planning, backup solutions are needed together with maintenance of key technologies and resources in the infrastructure. For example, continuous monitoring of key network components and servers help to keep unwanted interruptions to the minimum, and preventing them in advance.

A. *Information systems are more than technology*

It is generally understood that information technology is about technical components and software, or a combination of both. Technical components refer to various devices and technologies which connect computers, printers and other resources together. They include networking technologies which are needed for company-wide information sharing, and connecting to internet, for example. In addition, servers and storage-devices are technologies which are typically found in organization's information systems.

Software is another important component in information systems. Software is found in computers, in devices ranging from personal, mobile terminals to robust servers that provide computing power to large amount of users. Software is also a critical component in routers and switches, basically in all networking devices software routes data to correct destination. When we look at information systems from use's perspective the interface to systems is made of software, the terminal screen is filled with internet browsers, sales applications, bookkeeping software and the list goes on. Basically, there is a wide range of applications and systems covering all imaginable areas in human life. To summarize, information systems are usually understood as a system that contains both technical devices and software components.

It is important to notice that information systems and information systems management in general are considerably more than technology or software. Byrd and Turner [9] remark that information systems infrastructure can be divided into two main components: technical IT infrastructure and human IT infrastructure. Here the technical infrastructure refers to aforementioned technical and software components in information systems.

The other component in information systems is the human component [3], [10]. It relates to information systems users skills on an organizational and individual level. It is about competencies, expertise, motivation and commitment to use, maintain and develop the technologies [3], [11], [9]. Lee et al. [12] notice that human component in information systems infrastructure is a combination of expertize in four key areas:

- Technology management
- Technical issues
- Business understanding and
- Interpersonal skills and management

The first key area, technology management should be understood as organizational ability to use information technology in a way that it enables and supports organization's activities, and makes it possible to reach business targets [13], [12], [14], [15]. It is a result of interplay between IT department and business management. In an ideal situation IT people have an up-to-date understanding of recent and forthcoming technologies, and they are able to forward key technologies and their potential to key business developers. On the other hand, business managers and developers should be able to communicate operational and strategic goals to IT staff, so that they can together evaluate and adapt key technologies in a way that they make business targets possible to achieve. This communication and mutual understanding is very important, still in many cases challenging in real life.

Successful information systems management requires understanding of technologies. However, it does not mean that all people working in the IT department should have long technical education or expertize. Often the successfulness of information systems is based on having the ability to adapt technologies to enable and support business activities, and this ability may have little to do with deep technical knowledge or engineering degrees. As a result, having a IT manager with business background with backed with technical experts in the IT department might be optimal, given the idea of IT department as a provider of solid infrastructure that creates business potential to the company.

It is obvious that in information systems management there is a need for technical knowledge technical knowledge in various technologies, systems and networking. Expertize is needed both on a detailed level, but also broad general understanding of how different technologies fit into the overall infrastructure is required [12], [16].

In larger organizations the recruitment policy may support this by searching talents with different expertize. As a result, one person may specialize in user support while another is expert in networking configurations, for example. However, in smaller companies it is more challenging to obtain expertize that is detailed enough in different technologies. There may be only few, or even one person who is in charge of information systems in the organization. Furthermore, it may be the case that this person has also other duties in the organization. In this kind of situation Having knowledge in wide range of different technologies and systems and knowing each particular system on a detailed technical level is seldom possible. The industry is changing and developing fast, it is therefore hard to maintain expertize if there are also other works to be done, which is a typical situation in a small company. In this kind of situation using expertise from external partners, vendors and systems providers can help in managing technologies and systems.

Business understanding refers to understanding business processes, customers, and business targets in the organization. Business understanding is needed in selecting technologies, systems and applications that make it possible to meet business needs and operational targets [12]. Development of information system, choosing technologies and adapting them into the existing infrastructure should be approached from the business perspective. However, technical excellence or superior performance are secondary issues as development should bring business value to the organization. Therefore, business knowledge is an ingredient that is needed in developing information systems so that business targets, operative and strategic goals can be met [17].

There is a need for interpersonal skills in information systems management. It is evident that information systems management is not successful if there should be lack of communication, misunderstandings, or other problems between those involved in development activities. Development is about cooperation with people in the organization and with external partners. There is a need to understand requirements from operative actions and processes, combine them with technical innovations and see the potential for successful business. It is clear that communication skills are in a critical role in information systems management and development activities.

III. Towards Integration

Information systems are a combination of technologies, physical devices and software, together with knowledge and understanding on how to use them to reach desired goals. As a result, there are several technologies, applications that need to work together in order to meet targets of the users of the systems. These can be considered as modules, with different contents and purposes. Let us look at modules and modularity in more detail.

A. *Modules and Information Systems*

Modules and modularity are terms with many definitions [18], [19]. Here it refers to systems that are built of components, technologies and software elements. It is important that functions of different components, relationships and architecture can be described, in order to make modules and the overall system manageable [19]. Modularity is a concept that is based on clearly defined activities within individual modules, and the idea of connecting modules with other modules. It allows creating different combinations of modules, so that it is possible to develop solutions for different purposes using modules. Therefore, individual modules can be seen as building blocks of information systems. The modules and their connections need to be described so that modularity as whole becomes possible. Modularity is a concept with components that can be combined, separated and recombined. Modularity also refers both to the relative tightness of coupling different components and to the degree of which the 'rules' of the system architecture allow mixing and matching of components [20]. Consequently, information systems developers use modularity as a design method in developing systems into existing infrastructure, often using technologies and systems that can be considered as modules.

There are several key issues in modularity. According to Baldwin and Clark [21] modular design approach can further be divided into

- architecture

- interfaces and
- standards

Modularity is based on decomposable architecture [22], [23], [18]. However, modularity as such is a development method, it requires understanding of development goals and targets. Architecture acts as a blueprint for designers of information systems. It defines which modules will be needed in the infrastructure and what is their role. In other words, having a clear view of the information system and it's future development is needed.

Modular approach would not be possible without independency of components [22], [20], [23]. Modularity relies on connections and connectivity between different modules. These interfaces need to be defined and standardized, so that it is possible to connect modules together. It is important to be able to use different modules in different configurations, in environments and purposes that may not be known in advance. Consequently, modularity allows technologies and systems to be flexibly combined in order to create unique bundles and solutions into different environments [19], [24], [25]. It also makes it possible to take advantage of capabilities beyond organizational boundaries, use expertize from systems providers and outside experts, for example [21], [23].

In general, the role of standards is important in information systems. They are needed to enable compatibility between modules. Furthermore, there has to be standards for actions, performance or activities that each module is supposed to perform. Flexibility to create new systems and solutions would not be possible without standardized modules and their interfaces which are acknowledged and mutually shared across the industry and the organization which develops information systems infrastructure [26]. In information systems development the role of standards becomes visible also in the way developers aim to guarantee the successfulness of the results, they seek capable partners and manufacturers whose products follow standards in order to increase reliability and flexibility of the systems and infrastructures [1].

B. *The Role of Standards*

The interoperability of technologies and systems is important. Therefore, instead of picking the best possible individual system for a given need, companies increasingly choose the best system within a standard [27]. This means that if the technology would be advanced and good as such, but have it's own proprietary functions, be compatible only with technologies from the same manufacturer or otherwise not follow standards, it might be better to look elsewhere for a solution. It is in each organizations interest to ensure that its information system addresses standards, or understand what might happen if standards should deliberately be ignored [28].

Developers need to be careful when choosing systems and technologies. It is possible that manufacturers innovate and provide technologies which are not in fully compatible with other manufacturers' products. Keen and Cummins [27] have found several reasons for this: manufacturers wish to protect their installed base, there are difficulties in just making new technology work, and a lack of standards may exist, especially in technologies that are developing fast. Manufacturers may also be tempted to rush releasing their products, gaining market share can be more important than thorough testing of technology before selling it to customers.

There are different kinds of standards. David and Greenstein [29] categorize standards into three classes: reference, minimum quality and compatibility standards. Reference standards are guidelines that manufacturers should follow. Minimum quality standards are another type of standards, they are to provide level of performance, speed or define performance that technology should meet or exceed. Compatibility standards are particularly important in networking and connecting systems together, they ensure that a component adheres to requirements that allows it to be installed into a larger system. Especially in rapidly developing areas of technology there may not be standards, as they have not been defined.

It is evident that standards are central to development of compatible and open information systems. There different types of standards, and they may range from narrow to broad, specific to vague, complex to simple, or formal to informal [27]. When a standard has not been understood, when there are different interpretations of a standard, the results can be seen in incompatibility or lack of interoperability, even though there are technologies that are designed to meet standards. In real life some de facto -technologies or narrow vendor-specific systems can be more open than formal open standards. This is because they can be clearly specified, stable and openly available, so they can be taken into consideration in products made by other providers.

The result is that organizations are challenged to install and integrate new products into an existing multivendor environment. IT developers and IT departments approach to standards can range from awareness of emerging standards, to substantial participation in standards setting [28]. Unclear standards risk the infrastructure, there is always fear of incompatibility between different systems, modules and technologies. Hanseth et al. [30] argue that broad participation in development process helps to keep technology in control and avoids misunderstandings that lead to problems in the future. Best interoperability is result of an evolutionary process where standards are understood, developed and implemented in cooperation with users of technologies and developers of standards [30], [27].

IV. Conclusion

In general, the information systems in the organization should be developed so that the infrastructure allows the organization to share data independently of applications or hardware components. Development needs guidelines and rules that specify, for example, where data is stored, what

hardware and software is invested in, and how support function is organized. When the guidelines have been set each investment in new technologies move the company toward a system that supports business operations. Consequently, standards make it possible to connect otherwise separate technologies and systems within the organization and also allow connecting to information systems of selected business partners [31], [32].

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