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DELTA -AN ARCHITECTURE FOR MANAGEMENT OF ENTERPRISE DEVELOPMENT

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Abstract

Management of enterprise development refers to the complex task of transforming an enterprise from one state to another (desirable) state in a controlled manner. This paper presents a framework that enables the systematization of empirical as well as theoretical knowledge contributions relevant for management of enterprise development. The framework is validated theoretically as well as empirically. The framework has proved effective to systemize and relate this variety of issues and provide a tool for comprehensibility for practitioners trying to grasp the development situation in which they engage. The framework is a valid foundation for elaborating a knowledgebase supporting the management of enterprise and IS development in complex organisations.

Keywords: Management, Development, Architecture

1 INTRODUCTION

This paper presents a framework for management of enterprise- and IT development. Enterprise development refers to the complex task of transforming an enterprise from one state to another (desirable) state in a controlled manner. This involves the coordination of the development of information systems/information technology (IS/IT) and the development of business and business processes, a task often viewed as one of the most challenging for modern enterprises. From now on the paper will refer to this activity as enterprise development.

As a response to the need for holistic approaches in order to address and manage the complex interrelationships that inevitably exist in enterprise development activities, the development and use of architectural frameworks have been gaining popularity since Zachman's first presentation of the idea (Zachman 1987), work in turn building to a large extent on the early works of Langefors on information systems (Langefors 1966, 1973 a b and 1993).

Langefors' main contribution to the field; the interrelationship between data analyzing/modeling and categorization of knowledge-domains regarding field of usage, is well described in the argumentation surrounding his Infological equation (Langefors, 1973), and remains a valid scientific bridgehead between human, organization and technology matters in the IS field.

As our tools and techniques for studying these matters grow increasingly sophisticated, so must our ability to organize and use them. Thereby, the relevance and future use of an architectural approach remains valid (Magoulas and Pessi, 1998).

This framework was developed in a research effort (DELTA Slutrapport, 2001) in management of coordinated development of organisations and their information systems. In this field practitioners face a variety of critical issues with dynamic and complex causal relations. The framework is a direct response to the need for: i) sorting up a vast variety of issues that are critical to management of development and ii) appropriate management development instruments to address them. Thus, the Framework will provide a reference environment for empirical as well as theoretical contributions in the knowledge creation concerning management of enterprise development.

2 METHOD

Researchers used an overall approach in this study inspired by grounded theory (Glaser & Strauss 1967) so the framework was elaborated, evaluated and revised through a combination of empirically and theoretically oriented activities.

The empirical foundation is based on practitioners' experience from major Swedish organisations. Data was collected in interviews and workshops. The starting point was 20 interviews with top level and project level managers of development work from 6 large organisations in varying industries and public sector providing a picture of issues that development managers consider important to coordinated enterprise and information systems development. Results from the interview were processed in workshops with a partly different set of practitioners from some of the interviewed organisations. The research team developed the frameworks in iterations based on empirical results, discussions and theoretical studies of other architectural frameworks for enterprise and information systems design. Support for the relevance of studied issues and elements of the framework was found in other empirical studies e.g. Lythinen (2000).

Once the framework was constructed it was validated both with practitioners and with literature. Practitioner's reaction was collected directly on a presentation of the framework, and via situation analysis of their particular developmental situation in four organisations based on the framework followed by presentation and discussion in common workshops. (DELTA slutrapport 2001).

The framework is supported by literature in two ways: firstly, the framework has been inspired and based partly on known elements and their relations from literature, secondly once formulated, the framework has served as tools to systemize development management instruments from literature based on what elements and relations they address. Furthermore the framework has proved useful in a number of courses, master thesis's and student projects in education at Göteborg School of Economics and Commercial Law.

The supporting theoretical evidence for the model is presented in chapter 3, theoretical foundation. Supporting empirical material is presented in section 4, Empirical foundation.

The use of grounded theory (Glaser & Strauss 1967) gave support in the combination of fieldwork and theoretical studies. For a more quantitative description of the empirical activities related to this study, please read Enquist and Holmqvist (2003).

3 THEORETICAL FOUNDATION

There are many competing disciplines addressing the challenges related to supporting the development and use of information systems in enterprises. The complexity has increased in numerous areas related to the same; (i) the development process, (ii) the technology in itself, (iii) the commercial arrangement surrounding the development and (iv) the environment where the information systems are used. Means for coping with the ever increasing complexity is, of course, knowledge regarding the matter at hand and further more, knowledge regarding how the matter relates to other relevant matters.

One way of arranging knowledge, both empirical and theoretical, is by the use of architectures. An architecture is a higher order logic, explaining and giving structure and relationships between entities, thus enabling a holistic approach to issues otherwise not easily handled holistically. Buildings are an example. Doors, walls, roof, carpentering and contracting are all separate entities; an architectural plan of the building shows how they relate in that specific building and what type of competence is needed in order to put the respective entity in place. Conceptual architectures have traditionally been represented by box-and-line drawings. The following things are usually defined in such a drawing: (i) nature of components, (ii) component properties, (iii) semantics of connections between components and (iv) behaviour of a system as a whole.

One may follow the development of architectures relevant for management of development through the following selection of publications: Simon 1962, Leavitt 1965, Langefors 1966, 1973a, 1973b, 1993, Churchman 1971, Lynch 1985, Zachman 1987, Sowa and Zachman 1992, Bernus and Nemes 1996, Bernus 1997, Hoffman 1988, Checkland 1989, 1989 and Magoulas and Pessi 1998.

In parallel with the continuous innovations regarding information technology and its use in enterprises that started in the 60s, Börje Langefors lay the foundation for management of enterprise development by his structured approach to systems analysis (Langefors, 1966, 1973a, 1973b, 1993). Langefors infological equation explains the relationship between data, information and knowledge, thus a corner-stone in any argumentation for specific domain knowledge and the necessity for interaction between stakeholders. This applies in technological development as well as enterprise development. Related to Langefors works, Simon (1962) developed a concept for an architecture of complexity. These works still provide a solid ground for more recent contributions, one of the most influential is Checkland (1989) who highlights the "soft" (human/social) aspects related to information systems. The common denominator in these works is the use of architectures as higher logic when studying aspects related to the development and use of information systems in enterprises.

During recent years, enabling infrastructure in combination with new information systems types has made new sourcing arrangements possible (Cross et al. 1997, Clark et al, 1997). These arrangements demands new internal organisation for the management of information in enterprises (Venkatraman 1997, Keen 1999, Sambamurthy 2000). The necessity to align business and IT activities has been stressed by numerous authors (Venkatraman 1997, Keen 1999, Sambamurthy 2000).

Contemporary enterprise needs for management integrative intelligence (regarding aspects of business and technology) are stressed by numerous sources (Venkatraman 1997, Keen 1999, Sambamurthy 2000).

Based on above theoretical starting point, this chapter will introduce a framework for management of enterprise development.

3.1 The DELTA Framework

The basic building blocks of an enterprise may be seen in terms of its people, goals, social structure, technology and environment. Put together, these building blocks constitute an integrated whole. This implies that development of this whole must include coordinated development of all building blocks since they are interdependent. The enterprise as an integrated whole with complex relations between entities has been described in different perspectives by a number of people (Dahlbom and Mathiassen, 1993; Lynch, 1985; Aristotle through Taylor, 1944). An enterprise may be defined in terms of the following basic building blocks: (1) organization, (2) people, (3) shared goals and (4) technology in use.

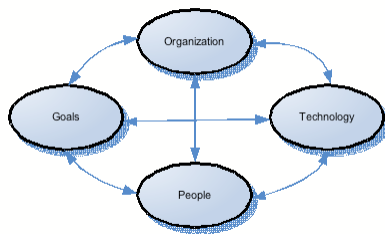


Figure 1. Interdependent aspects of an enterprise

With regard to design and development of information systems, the enterprise may be viewed as a set of domains of knowledge (Langefors, 1966). According to Earl (1989) the domains of Business, Information Systems and Information Technology should be defined and planned for in coordinated sub strategies of the enterprise.

The framework present a model of enterprise development based on four elements and their interrelations. The elements represent high level entities describing the content of development work, that is, what development managers need to manage. The following sections introduce the elements and their content followed by a presentation of their relations. This section have an emphasis on theoretical references, section 4 will provide empirical references.

The architecture for enterprise development comprise of four basic elements of development. These elements and their interrelationship are described below.

The basic elements of enterprise development are:

- Enterprise images
- Stakeholders
- Development goals
- Development process

When viewed together, they constitute the Framework.

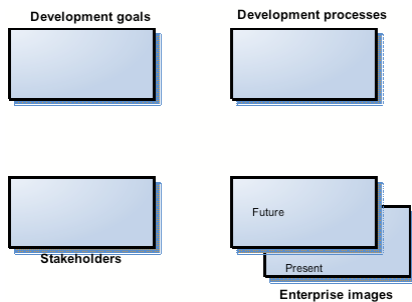


Figure 2. Basic elements of enterprise development

For each type of element there is a structure of entities. In the following section we give example of types of entities, structures and relations within each type of element and refer to supporting theory.

3.1.1 Enterprise images

Enterprise images of the present describe the enterprise in its environment. There are a multitude of images, differentiated for instance by organization, with a least one set of image per organizational unit, by function, by geography or by time etc (Simon, 1962). Each image is being based on structures of entities in the enterprise and in the environment (Simon, 1962). The choice of analytical approach to enterprise analysis and design, define what types of entities to search for/define and build the images on. These entities (e.g. processes, organizational units, resources, IS, plants, staff) may be more or less well defined and interfaced.

In enterprise images, structures of entities are described in different patterns, based on an analytical perspective (Lynch, 1985 and Zachman, 1987). In an organizational perspective structures are based on communication and decision lines. In a functional perspective functions and their internal and external interfaces are identified. In an activity perspective tasks and corresponding activities are identified. In a resource perspective different types of resources are identified, like buildings, technology, information, humans and knowledge.

Strategic images of the future describe the enterprise in its environment at different future points in time. Images of the future may be differentiated into scenarios based on differing assumptions on conditions in near and far future (Lynch, 1985 and Zachman, 1987). Future images of the of the enterprise may be expressed in the same terms as the images of today, i.e. process models may be used for present images as well as future ones. There is a discrepancy in detail between images of current state and those of the future. Knowledge about the future decreases rapidly with increasing time distance, so these images will naturally be significantly less detailed.

Several authors have struggled with explaining issues of enterprise development and organizing. Depending on perspective, different lines of reasoning follows along with appropriate tools for visualizing the concept.

The diversity of inconsistent, contradictory and incomplete theories and models for understanding, designing and managing complex enterprises and their integrated IS result in complexities (Magoulas and Pessi 1998, Enquist and Makrygiannis 1998). Porter (1985) describes an orgnaization in terms of its value chain, primary and secondary processes and their respective interactions. One technique for modelling systems in enterprise images is the Unified Modeling Language (UML), a non-proprietary, object modeling and specification language commonly used in software engineering (Chonoles at al 2003, Penker et al 2003, Coad et al 1999 and Martin 2003).

3.1.2 Stakeholders

Stakeholders refer to actors that for some reason have (or should have) an influence on the development of an enterprise and include everyone that is affected by and/or have an influence on the

enterprise today or in the future (Lynch, 1985; Simon, 1962; Zachman, 1987). These may be customers, employees, management, board, owners, suppliers, co-operators, competitors, neighbours, administration, government etc.

The stakeholders in an enterprise may be structured in several different ways; employees according to role, responsibility, education etc; customers according to turnover, product/service segment, market etc; owners according to share, influence and so on (Lynch, 1985; Simon, 1962; Zachman, 1987; Porter, 1980).

3.1.3 Development goals

Development goals are expressions of improvements, which have been derived from the current and future images of the enterprise (Lynch, 1985 and Simon, 1962). They reflect the issues of enterprise identity and enterprise behavior. Development goals define direction and magnitude of change of the enterprise (ends) and indicate policies (principles of method, resource limits, responsibility and authority etc; means) for the development and change process (Lynch, 1985 and Simon, 1962).

In some cases goals can be operationally expressed so that meaningful measures; qualitative or quantitative, can be established. Structure of differentiated development goals e.g. based on time (vision, goals), based on function (production, distribution, product development, IS), based on product/market/customer, knowledge development etc. Relations among development goals are for instance goals dependencies, goal balances, and temporal relations.

3.1.4 Development process

Development process concern the activities pursued to develop or change entities and to integrate these in the enterprise, thereby changing the enterprise from one state to another (Simon; 1962, 1969). The development process may contain a large number of activities, some as formal projects, other less explicit like task groups, day-to-day improvement on a local basis. Most organizations have performance improvement goals encouraging employees to always implement improvements on a local basis as part of their regular work. Some of these activities are pursued under control of the enterprise, while others are under control of external actors like suppliers of resources and sub-contractors/consultants.

The development process is often not as well specified as other processes of the enterprise (Simon; 1962, 1969). Development activities may be regarded as one-time shots and are managed beside the normal structures. On one hand, this gives freedom to set up unique organizational structures for development work but on the other hand it may be difficult to co-ordinate development work throughout the organization because there is nobody who has the whole picture (Simon 1962 and 1969).

Zachmans architectural framework is developed in order to keep track of key responsibilities correlated to various roles in the development work (Zachman 1987)

Development work may be categorized in several structures, by enterprise entity of interest, development goal, organizational belonging, time range, by magnitude or by strategic importance etc. Development activities may follow different process patterns depending on the degree of innovation, uncertainty and lack of knowledge at hand. Activities using different patterns may be difficult to co-ordinate due to mismatch between the patterns. Some of these patterns are illustrated in the figure below.

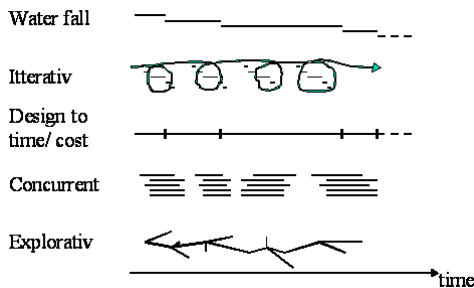


Figure 3. Development process patterns

3.2 Relationships between elements

The four elements constitute 6 relationships between the elements. Below follows a description of each relationship related to supporting theory.

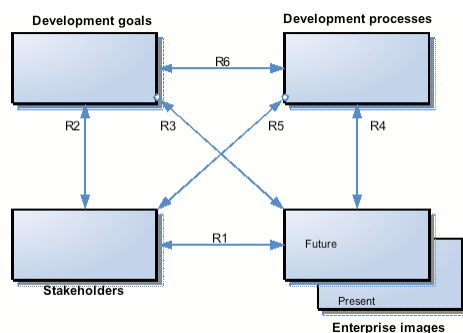


Figure 4 Relationships between elements of development

R1 Stakeholders – Enterprise images

The relationship between Stakeholders and enterprise images focuses on the different perceptions regarding the enterprise that the stakeholders inevitably have. This includes the perception regarding the present, as well as future views of the enterprise. Depending on stakeholder, their view will differ. The enterprise development manager must continuously have updated information regarding current stakeholder views.

Several authors have given this relationship significant attention. Mylopoulos (1988) argues for the integration of enterprise out of a socio-ontological perspective. Sanches (2000) concretises the need for a knowledge architecture that cover an enterprise wide development of competencies. Porter defines competitive structures in terms of external stakeholders and their forces (Porter, 1980). Checkland coined the term soft system and has built a framework for analysing social aspects related to information systems work, Soft systems methodology (Checkland 1981, 1998; Flood and Jackson 1996 and Midgley 2000, 2004).

R2 Stakeholders – Development goals

The relationship between stakeholders and development goals focus on the different perceptions regarding development goals and sub-goals that the various stakeholders have. Different stakeholders will have different views on the various goals, and act towards some of them, and be more passive regarding others, in some cases even work actively against them. Logically, the various stakeholders will act towards development goals in harmony with their own goals, and vic versa, counteract goals that are conflicting with their own. The development manager must have updated information regarding current stakeholders views regarding development goals.

R3 Development goals – Enterprise images

Development goal connect to deltas in entities in the enterprise, this relationship balances the development goals with the development work that must occur in order to change the present enterprise into the planned future enterprise. It is important to have goals that are relevant with regards to the actual work that are conducted by the enterprise. Goals and subgoals must also be in accordance with the future enterprise. As future enterprise images change, so must also the corresponding development goals.

R4 Development processes- Enterprise images

The relationship between Development processes and enterprise images is concerned with how the development work is to be organized and executed in order to change the enterprise from its present state to desired future state. The relationship also comprise how the enterprise is to implement results from development activities. Befor this is done, no actual change will occur.

The planning process of coordinated enterprise and information systems refers to the planning activities within or between a particular set of organization. This coordination can take different forms such as administrative, sequential, reciprocal or fully integrated. Furthermore, the common plan is used to coordinate any activity of in-house or outsourced development. (King and Sethi 2001).

Bernus (1997) propose the use of a concept of enterprise life cycle to denote the issues of an ongoing coordination of enterprise process development and information systems development.

The Rational Unified Process (RUP) is an iterative software development process. RUP is not a single concrete prescriptive process, but rather an adaptable process framework. RUP describes how to develop software effectively using proven techniques. While the RUP encompasses a large number of different activities, it is also intended to be tailored, in the sense of selecting the development processes appropriate to a particular software project or development organization (www.rational.com).

SSADM is a waterfall method by which an IS design can be arrived at; SSADM can be thought to represent a pinnacle of the rigorous document-led approach to system design, and contrasts with more contemporary Rapid Application Development methods such as DSDM. SSADM is one particular implementation and builds on the work of different schools of development methods, some of the key members of which included: Peter Checkland, Larry Constantine, Chris Gane & Trish Sarson, Ed Yourdon and Michael A. Jackson.

R5 Development processes – Stakeholders

The relationship between Development processes and Stakeholders focuses on how specific stakeholders are involved, or not involved, in the various development activities. Different stakeholders have different views regarding what development work that should be prioritized, how that work should be organized and whom should conduct the actual work. Different stakeholders will, depending on their own development agenda, support or act against the development processes. The enterprise development management must have an updated view regarding the various stakeholders views concerning the development processes.

Nolan et al emphasize the need for fast development and change in heterogeneous environments, the need for short lead-time and delivery of IT products that meet the current user requirements. This approach is strong on hard aspects, such as IT products and enterprise design but is week concerning softer issues, such as the co-coordinated development of knowledge and skills among actors in a changing enterprise. (Nolan 1979)

Program management provides a layer above project management focusing on selecting the best group of programes, defining them in terms of their constituent projects and providing an infrastructure where projects can be run successfully but leaving project management to the project management community (www.12manage.com).

R6 Development goals – Development processes

This relationship balances the development work with the development goals. All development work is to its nature concerned with, at least to some extent, explorative work. Thus, as development work progress, and new insights are reached, goals and plans might be affected. Goals must continually be updated with regards to development process achievements in order to stay relevant.

The development process may follow several different patterns depending on the degree of uncertainty in ends as well as in means. In other words, uncertainty derived from choosing the product to design and the problem solving process influences the development process pattern. This framework is based on similar frameworks presented by Daft and Macintosh, Hedberg and Jönsson and Sanchez, here modified according to the concept of uncertainty. (Daft and Macintosh 1978, Hedberg and Jönsson 1978 and Sanches 2000).

4 EMPIRICAL FOUNDATION

The presentation of the empirical foundation is based on statements by practitioners engaged in research activities resulting in the framework. The statements address issues of concern to the practitioner striving to coordinate enterprise and information systems change. These issues are often interrelated and the practitioners lack appropriate instruments to comprehend causalities and address them. Results in terms of issues and their importance to coordinated development are presented in (Enquist and Holmqvist 2003).

The results include a structure of statement/issues organised in 9 subject areas and evaluations of these subjects e.g. in terms of how critical they are to coordinated development. The most important subject areas both in terms number of statements and in terms of being critical is ‘Management and management instruments’ indicating that current management practices and instruments are insufficient to cope with the issues at hand (Enquist and Holmqvist 2003).

Similar empirical results have been published by Lyythinen (2000) who investigates how to identify and address risk components in software development projects.

For the purpose of demonstrating connection between issues of interest to practitioners and the framework a selection of statements and the complex causal relation are systemized with the framework bellow.

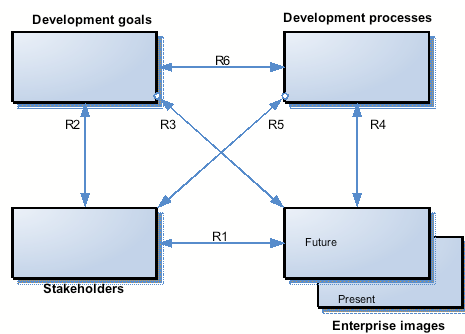


Figure 5

The following short forms are used in referring to the framework: Enterprise Images present (EI-P), Enterprise Images future (EI-F), Stakeholders (S), Development Goals (DG), Development Processes (DP) and pairs of them are used to denote the relations.

Complexity. Large enterprise which involve lots of people e.g. 100 leaders with their own priorities. The statement address aspects of complexity in EI and in S resulting in diversity and uncoordinated priorities of DG and actions in DP. Complexity indicate that it is difficult to comprehend the enterprise and its information systems and thus to grasp relations between change entities, to share awareness and provide coordinated direction to the unique leaders and their development activities.

Enterprise personnel have such a workload that they can not be part of the development. Since this group represent key stakeholders in enterprise and IS design their absence in development work lead to a number of issues: lack of knowledge about specific conditions and ends-means relations in the entities addressed, lack of evaluation of suggested solutions, knowledge build-up among other actors than those involved in the change entity, problem understanding and solutions suggestions biased by knowledge and interest of the “substitute users” involved in the development. This statement concerns primarily the relation DP – S but also EI-P, EI-F and DP with corresponding relations.

The number of consultants within projects, who later disappear with all their knowledge. Development project not only produce new or changed entities in the enterprise, they also produce knowledge about those entities and should provide that knowledge to the enterprise for understanding the entities and entity relations in use and for future development. Lack of knowledge among stakeholders about entities and changes in them is also a stated issue itself. This topic concern DP, DP-EI-F and DP-S.

Patience and understanding in order to establish a new way of working, including the infrastructure. This was stated by a person responsible for a development activity aiming at improving the development process by introducing an infrastructure based development approach and corresponding methods. The statement concern issues of DP itself, stakeholder expectation and knowledge of DP, immaturity of Enterprise entities (the infrastructure itself) and lack of acceptance of DGs for the DP itself among certain stakeholders . How do you introduce an infrastructure that will enable coordinated enterprise and IS design when it requires a higher level of coordinated action than the stakeholders currently provide?

Timing aspect, when is it profitable to introduce new technology? Design of Information systems is constantly challenged by new technology opportunities that need be balanced against profitability but also against capability to handle it in development work. Introduction of new technology is associated with issues of EI starting in present and shaping of future. For new technology to find its place there must be entities in the enterprise where it has a use and potential to contribute to better solutions to real problems. There are issues about stakeholder’s knowledge about concerned enterprise entities, the new technology and understanding of ends-means-relations. A risk with new technology is that current development organisation may not be capable to handle it as is, leading to disturbances in development work and inappropriate solutions. The statement concern issues in EI-P, EI-F, S and DP and in the relations S-EIx, DP-EI-F.

5 DISCUSSION

Development and change of business and information systems in large organisations is a complex task involving a multitude of entities, stakeholders, interests, development projects and change implementation activities dispersed geographically, organisationally, culturally and intellectually throughout the structures of the enterprise and its surrounding external stakeholders.

The empirical results point to shortcomings in management and management instruments to address the large variety of issues that are critical factors as a main cause of failure to coordinate development and change in enterprise and information systems. The results also identify a variety of issues and interdependencies between them, which require management attention and efforts to be resolved.

The framework has proved effective to systemize and relate this variety of issues and provide a tool for comprehensibility for practitioners trying to grasp the development situation in which they engage.

The framework has a clear reference to previews concepts, models and frameworks addressing development of enterprise and IS.

The framework is a valid foundation for elaborating a knowledgebase supporting the management of enterprise and IS development in complex organisations.

6 FUTURE RESEARCH

Future research topics include: broadening the empirical and theoretical foundation, elaboration of the procedural side of management, design of management adaptively to fit current and changes in the developmental situations, method and instrument frameworks to support adaptive management, teaching management of coordinated enterprise and information systems design.

The framework will be used as a reference environment in the future research; both for systematising issues of development work and supporting intellectual instruments for development work (such as methods and theories). Thus, it may be viewed as an architectural framework for management of development. We will refer to the framework as the DELTA model.

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