Sociaal-organisatorische gevolgen van kennis-technologie: een procesbenadering en actorperspectief
Metselaar, C.M.T.

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SUMMARY

SOCIAL-ORGANISATIONAL EFFECTS OF KNOWLEDGE-BASED TECHNOLOGY

The central research questions of this thesis are:

What are the connections between the actions during the development and the implementation process of a knowledge-based system on the one hand and the social-organisational effects of this knowledge based system on the other hand?

In which way is co-operation between different actors, especially between producers and users of the system, conducive to the mutual adaptation between a knowledge-based system and the organisation in which the system will be implemented?

For the purpose of this thesis, theories and results of research projects of different scientific fields have been integrated in an analytical framework. Answering the research questions requires an integral approach, in which connections are made between actions and effects. The analytical framework is applied in three case studies: XCON, XSEL and OpEx.

Research projects in the field of ‘technology, work and organisation’ mostly focus either on the assessment of the effects of the technology or on the construction of the technology. Within the first perspective, statements are made with a technological deterministic tendency: technology leads to specific positive or negative effects. Within this perspective it is often neglected that outcomes are the result of a complex process of interaction between technological and organisational changes. In the second view, the main focus is on the process of development, while technology is regarded as a ‘social construct’: technology is the outcome of people’s choices and therefore flexible and can be influenced. Here, one ignores the fact that those technological choices that are made in the past have a structuring influence on the subsequent technological and organisational choices to be made: technology is to some extent a deterministic factor. Alternative technological or organisational solutions are hampered or even blocked.

This research project focuses on the connections between the effects of knowledge-based systems, on the one hand, and on the technological and organisational choices that lay the foundations of these effects, on the other hand.

The research results show in detail that one cannot speak about effects of knowledge-based technology in a deterministic way. The effects depend on a large amount of context related technological and organisational decisions. However these decisions structure the course of the process.
Processes of structuration as a link between actions and structure

Insight into this dynamic relationship is gained by applying a process approach. Two variants of a process approach of technological development fit closely to the research questions of this thesis, i.e. the theoretical perspectives of Orlikowski and of Leonard-Barton. However, in the model of Leonard-Barton too little attention is paid to the actions, while the model of Orlikowski sheds insufficient light on the cyclical character of the development and implementation process. The interaction between technological and organisational changes as an ongoing process is insufficiently recognised by her.

Both models have been modified and integrated, whereby a connection has been made between the mutual adaptation of technology and organisation on the one hand and the realisation of this mutual adaptation by actions on the other hand. The connections between actions and structure and between technological and organisational changes are shown in figure 1.

Mirroring around the horizontal axis shows that the structural properties of the technology and the structural properties of the organisation influence the actions and that by these actions these structural properties are continued or reinforced, weakened or transformed. Both theoretical extremes are placed at the horizontal axis: technology as a 'social construct' and technology as a 'deterministic factor'.

Figure 1 The mutual influencing of technology and organisation by way of a process of structuration

Arrow IoC reflects the organisational changes, arrow ITc reflects the technological changes. Mirroring around the vertical axis shows the reciprocal influence of technological and organisational changes. The theoretical extremes of this dimension are placed at the vertical axis: 'technology push' and 'demand pull'.

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In Giddens' theory on structuration a connection is made between 'action' and 'structure'. Structures of 'signification', 'domination' and 'legitimation' are reproduced or transformed during processes of interaction. The structures of 'signification', 'domination' and 'legitimation' have a structuring impact on the interaction processes, i.e. on processes of communication, use of power and moral sanctioning.

The elements of Giddens' theory on structuration, forming the foundation of the theory of Orlikowski, are included in this model in order to gain an understanding of technological and organisational changes on an organisational level. The structural properties of technology and organisation are placed at the top of the figure. Interaction (communication, use of power and moral sanctioning) takes place in the arena of actors. Interpretative scheme's, resources and norms are used during actions and make up the cycles of change loc and lltc. For example, interpretative schemes of technical experts guide the technological changes and interpretative schemes of the management of the (user) organisation influence the organisational changes. By applying certain technological or organisational resources the process is directed in a specific way. Norms and values are of importance for legitimising choices. Through the use of resources actors can exert pressure to direct the process. Structures of 'signification', 'domination' and 'legitimation' are formed by participation and learning processes in the arena of actors. Convergence between technology and organisation is understood on the basis of congruence between structures of 'signification', 'domination' and 'legitimation' of the actors involved.

The three case studies show that many actors with different roles influence the process by the technological and organisational decisions that they make. The ways the actors cooperate influence the outcomes of the process. Learning by interaction between members of the user organisation and of the external producer, between knowledge engineers and organisational experts, and between domain experts and users has an impact on the level of convergence between technology and organisation.

By applying a process approach it becomes clear that effects have a dynamic character as well. The effects of a knowledge-based system change during the development, the implementation and the use of the system. However, at a certain moment in time the effects of a knowledge-based system can be described.

The effects of knowledge-based technology are analysed by relating social-organisational aspects from the research literature in the field of 'technology, work and organisation' to four dimensions of knowledge: the availability, the use, the development and the management of knowledge. These dimensions are also used for the assessment of the consequences of knowledge-based technology for the quality of work.

The case studies show that the development and the implementation of a knowledge-based system is a complex process of interaction between technological and organisational cycles of change, with a crucial influence of the composition of the arena of actors. The composition of the arena of actors and the way the actors interact are changing during the process as well. Dominant actors influence the formation of the arena of actors. The different actors in the arena put technological and organisational problems on the agenda and direct the way for finding solutions. The actors have unequal access to sources of power and they apply different norms and interpretative schemes. This influences their choices and hereby they direct the cycles of change. Because of these mechanisms,
structures of signification, legitimation and domination play a key role in the convergence between technology and organisation.

Processes of participation and learning are shaping structures of legitimation and signification. The actors involved have different kinds of expertise at their disposal. To which level they learn to understand each other influences the convergence between technology and organisation.

Knowledge-based technology has a structuring impact: through the use of the technology, structures of signification, domination and legitimation are enforced. The phase of knowledge analysis, in particular, has a profound impact on the structure of ‘signification’ and so influences the social structure of the organisation.

Research projects on the ‘success and failures’ of automation projects are mainly based on a static analysis of factors of success and failures. In this research project a process approach is applied. The research project shows that not the presence of specific factors is of importance, but the contingent role that these factors play in the process. As an illustration consider the success factor ‘sufficient experts available for the phase of knowledge analysis’. This factor of success turns into a factor of failure in case the structure of signification of the experts does not resemble the structure of signification of the management or of the designers. This mismatch can be solved in a process of participation or learning. Whether the outcomes will be interpreted as success or failure is again a matter of the (dominant) structures of signification and legitimation.

The case studies show that the acceptance of knowledge-based technology is the outcome of a process of change. A static use of critical success factors is not adequate because success and failure is to a large extent determined by the dynamics of the process.

Convergence between technology and organisation

The level of success of an innovation depends on the ‘match’ between technology and the organisation. For solving a ‘mismatch’, solutions can often be found in technological as well as in organisational directions. The technology adapts to the organisation, the organisation adjusts to the technology, or mutual adaptation between technology and organisation takes place. Risks are an indication of the ‘mismatches’ that can occur during the development and implementation process.

The analytical framework clarifies that technological choices are closely connected to organisational choices. Knowledge-based technology is intertwined in the primary processes of organisations and therefore the introduction of knowledge-based technology has become a strategic issue.

The development and implementation process of a knowledge-based system depends on the commitment of the management on various levels. The middle management can impede or obstruct processes of change by given insufficient support to technological and organisational delivery structures for the innovation aimed at. For example, the introduction of a knowledge-based system can fail because of an inadequate hardware infrastructure. Users are often unaware of the demarcation between the technological innovation and it’s surrounding technological and organisational delivery structures. All have to fit to make an innovation a success.
The development and implementation of a knowledge-based system requires technological as well as organisational expertise. Different choices require different types of expertise. The need for organisational expertise is great during the problem analysis, during the implementation of the system as well as for the assessment of social-organisational effects of the design choices.

With regard to the development of a knowledge-based system one can choose for a control or supportive solution. Knowledge-based technology can be applied as 'automating technology', to control knowledge intensive work. In this case, knowledge intensive processes will be standardised, the knowledge will be extracted from the employees and then hidden from them. Alternatively, knowledge-based technology can be used in a supportive way as 'informating technology' to enrich the work processes by increasing the insight in the knowledge intensive processes and by supporting learning opportunities. The three case studies show a control approach. For example, help functions were hardly developed and were considered as unimportant.

The case studies show that knowledge-based technology can solve a knowledge management problem, such as the lack of availability of knowledge or the lack of uniformity in the use of knowledge. But at the same time this may introduce a new knowledge management problem, such as a discrepancy between the management of the knowledge and the daily use of the knowledge.

In the case of knowledge-based technology maintenance is of crucial importance. A knowledge-based system loses its value when the knowledge incorporated in the system is no longer up to date. When the maintenance structure does not have a steady base in the organisation, the knowledge-based system will probably quickly fall into obsolescence.

In the early years of knowledge based technology a lack of integration of knowledge-based technology and information technology slowed down the diffusion of knowledge-based technology. The case studies clearly show the added value of the integration of knowledge-based technology and information technology. This integration increases the efficiency. And by this integration output of the knowledge-based system can be processed into documents that are spread around and that are widely used in the organisation.

**Effects of knowledge-based systems**

Knowledge-based systems can shed light on a lack of knowledge at the disposal of employees and can fill this gap. Knowledge-based systems can offer this knowledge as support, and therefore may improve the fit between the jobholder and the job.

Although central control increases by a knowledge-based system, this does not have to mean that all knowledge intensive tasks will be eliminated from the job. The case studies show that although autonomy in the work decreases, users still execute knowledge intensive tasks.

In the case that the experts are not the users of the system themselves, they co-operate in a process in making their own job partly redundant. After the introduction of the system supportive and controlling tasks in their work decrease. These tasks have been taken over by the knowledge-based system.
Knowledge-based technology allows knowledge to be made available in a decentralised way, without losing the central control. The increase in the availability of knowledge by the introduction of a knowledge-based system decreases the amount of communication in an organisation. Communication during daily work processes is of importance for the distribution of knowledge and for the development of knowledge. The introduction of the system decreases both possibilities for communication and learning, which are both important for the quality of working life.

The introduction of a knowledge-based system decreases the practical use of knowledge by the user, while the knowledge necessary to maintain this same system increases. This results in a tension between the use and the development of knowledge in an organisation. While the everyday use of knowledge by users decreases, they nevertheless have to be able to understand the decisions of the knowledge-based system and they have to be able to explain them to the customers. This results in a tension between the use of knowledge and the communication of knowledge.

A knowledge-based system influences the structure of signification. This becomes apparent in the communication between the members of the organisation after a while. They start using the vocabulary as incorporated in the system.

From a perspective of quality of work it is of importance to take social-organisational aspects into account as a design parameter during the design and implementation process of a knowledge-based system. Attention has to be paid especially to changes in the content of tasks, qualifications, communication and autonomy and learning opportunities.

Innovation and diffusion of knowledge-based technology

The development of a knowledge-based system requires close co-operation between the external producer of the system and the user organisation resulting in opportunities for mutual learning. The development of a knowledge-based system requires the knowledge of experts. Therefore, the relationship between the external producer and the user organisation can be characterised as a 'leading edge consumer' relationship. Need determinateness increases through the interaction between the external producer of knowledge-based technology and the user organisation. During the development process of a knowledge-based system the understanding of the opportunities and threats of the organisation increases.

When knowledge-based technology is applied for the first time in an organisation the availability of a champion is indispensable. This does not hold for organisations with a firm base of knowledge-based technology.

The integration of knowledge-based technology and information technology is an important condition for the diffusion of knowledge-based technology. In the beginning of knowledge-based technology knowledge-based systems have been developed in isolation, nowadays an integral approach of knowledge-based and information technology is more common.

The diffusion of knowledge-based technology has had a slow start. On the basis of theories on innovation and diffusion several explanations have been given for this slow, but steady spread of knowledge-based technology. The 'product' knowledge-based technology has a number of distinguishing characteristics that differ from conventional information technology. A concept for a specific type of knowledge-based system can be copied, the system itself usually not. As knowledge often becomes obsolete very soon a knowledge-based
system has to be updated continually. The development of a knowledge-based system requires investments in strong producer-user relationships. All this raises the costs of developing a knowledge-based system, especially the knowledge elicitation. In the research field of knowledge-based technology a large amount of effort is put into research projects on the potential for re-using knowledge. Finally, the transformation to a knowledge-oriented organisation is a process of large duration for many organisations.

This thesis has shown that the introduction of knowledge-based technology has a pervasive impact on many organisational processes. A knowledge-based system has a large impact on the daily work of the employees who use the system in their job. The knowledge-based system has consequences for the qualifications and autonomy and for the potential for communicating and learning on the job. For the organisation as a whole the system has an influence on the management of knowledge and on the processes of communication and learning. Knowledge management in an organisation requires an integral approach, in which technological as well as organisational solutions have to be taken into account.