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ANALYSIS OF ORGANISATIONS TO INTEGRATE MULTI-AGENT DESIGN SYSTEMS INTO IT LANDSCAPES

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ABSTRACT
Recent contributions in engineering design research demand qualitative and quantitative criteria to analyse organisations in order to judge whether information systems in engineering design (i.e. knowledge-based engineering systems) are generally applicable within these organisations. This analysis should be carried out within the early stages of the development of these systems.
The present paper is taken up this idea and focuses on multi-agent design systems (MADS) as one kind of knowledge-based engineering systems. By using the design engineering transformation system from design theory, suitable aspects of organisations (so called success factors) are developed. The actual results are qualitative criteria, which are subordinated to the success factors. In order to operationalise the criteria, applicable questions are derived. Finally, the criteria and questions deliver support to knowledge engineers in the early phases of the development of MADS. After a practical relevance has been evaluated, the success factors, criteria and questions are prepared for using them in the development of all knowledge-based engineering systems.

Keywords: multi-agent design systems, analysis of organisations, knowledge management

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1 INTRODUCTION

Multi-agent design systems (MADS) have been developed since the nineties of the last century, especially in basic research (Gero and Brazier, 2004). These systems consist of software agents that differ from common objects within object-oriented systems in terms of goal orientation, persistency, reactivity, etc. (Parunak, 1998). In general, MADS support design engineers throughout the entire engineering design process, and they can be separated into three distinctive classes: mobile agents, collaborative agent systems and personal assistants (Lander, 1997).

One example of a MADS is the ProKon system as a form of personal assistant. This system is developed within a public funded project and supports design engineers during the embodiment design phase (Kratzer et al., 2011). In connection with a CAD system, the ProKon system analyses digital product models (DPM) in accordance with Design for X guidelines (e.g. Design for Manufacturing), develops a solution in case of an inconsistency and realises this solution within the DPM. Figure 1 depicts these basic functionalities of the ProKon system using the example of an interference fit. Starting from an initial DPM, the design engineer undertakes a modification (e.g. reduction of the width of the hub). Based on this change, the ProKon system analyses the DPM in accordance with Design for Function, Design for Requirements and other guidelines. After that, it decides whether there is an inconsistency or not. In case of an inconsistency, a solution is found and deployed within the DPM. The ultimate goal of this project is to reduce the time required by design engineers for routine steps and to increase the quality of the product (Kratzer et al., 2011).

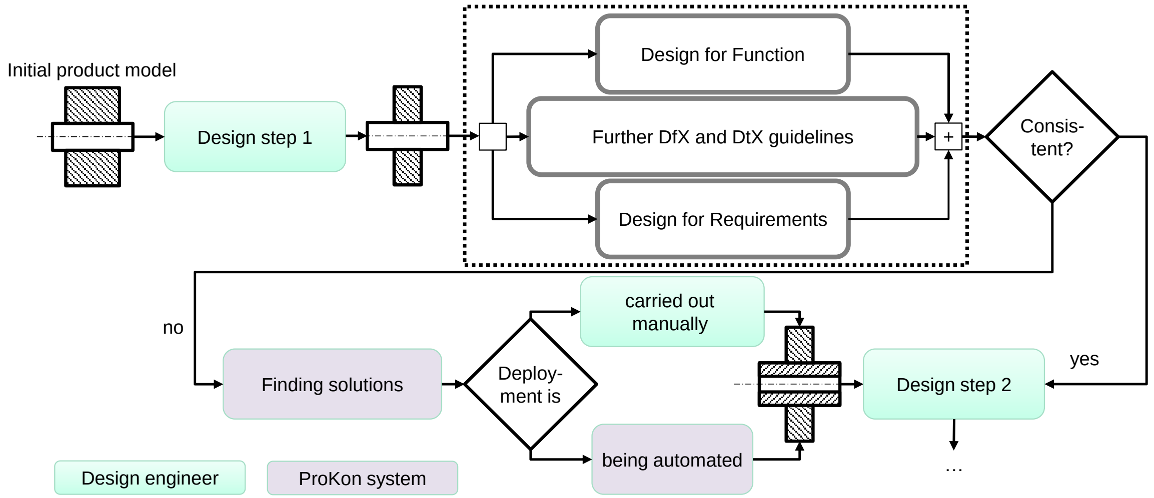

Figure 1. Basic functionality of the ProKon system

Although the ProKon system as a kind of information system (IS) has multiple advantages such as higher modularity, higher maintainability and a greater variety of solutions, these advantages could so far not be transferred into practice (Lander, 1997). The reason is that only the actual system is put into focus within the early stages of developing these systems. But, Grundstein et al. (2003) and ISO 10476 (2009) mention that the organisation has also a great influence on the development of these systems. ISO 10476 substantiated that with the creation of an enterprise viewpoint to analyse requirements (ISO, 2009). Thus, because of the neglecting focus on the organisation, a gap between the finally developed functionality and the initially defined functionality exists (Nissen et al., 2000). Therefore, Stokes (2001) and Verhagen et al. (2012) demand an analysis and assessment of both organisations and IS within the early stages of development in order to appropriately embed IS within the organisation. Furthermore, Verhagen et al. (2012) ask for criteria for deciding whether design objects (i.e. the product), engineering design processes and specific design tasks are suitable for support through an IS.

2 PROBLEM STATEMENT AND OBJECTIVES

Related to the demands of Stokes (2001) and Verhagen et al. (2012), a basis is missing in order to analysing IS and organisations in the field of knowledge-based engineering (KBE). Moreover, there is no method for making a final decision as to whether IS are applicable within the organisation and offers added value to it. In terms of the ProKon system, which is the system used as an example in this contribution, it means that there are no specific qualitative or quantitative indications as to whether the ProKon system could be applied within an organisation. Figure 2 depicts this failing and highlights the difference between the original development of the ProKon "core" system, which incorporates the basic functionality (analysing the DPM - finding a solution - realising the solution, cf. Figure 1) but neglects the organisation's specific contents (e.g. the product to be designed), and the enhancement of the core system to create a system which really supports the organisation.

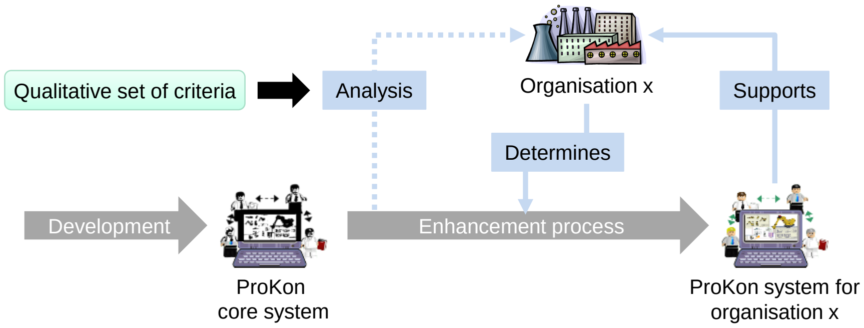

Figure 2. Process of developing and enhancing the ProKon system

Thus, the goal of this contribution is to develop a qualitative set of criteria for ascertaining how the organisation determines the enhancement process in detail. Therefore, the goal is to clarify precisely what has to be analysed in the organisation (i.e. which aspects have to be analysed). By means of this set of criteria, knowledge engineers as part of multidisciplinary team are enabled to judge whether the ProKon core system is generally applicable in a specific organisation and how it needs to be enhanced in order to deliver real support to the organisation (as representing this team, the knowledge engineer is only addressed in the following). This judgement step can be seen as a feasibility study, which is placed at the beginning of the enhancement process.

The overall research question of this contribution is as follows: "*Which aspects have to be analysed by knowledge engineers in organisations in order to judge whether MADS are generally applicable within these organisations and how they need to be enhanced in order to deliver support?*"

One approach for answering this question has been developed by Verhagen et al. (2012) who said that knowledge engineers have to analyse the following aspects in an organisation: design objects (e.g. a shaft as a part or a gearbox as an assembly), engineering design processes and specific design tasks (cf. Section 1). However, in order to create relevance in terms of these aspects, a generally accepted and already proved approach has to be taken as a foundation. One approach has been created in design science by Hubka and Eder (1996). Their design engineering transformation system goes further than Verhagen's approach due to the fact that engineering design knowledge and management of design processes are considered. The design engineering transformation system holistically unifies aspects to be analysed within an organisation. In this way, knowledge engineers are unable to neglect important aspects. Thus, a first hypothesis can be worded as follows: "*By analysing the organisation by means of aspects suggested by the design engineering transformation system by Hubka and Eder (1996), knowledge engineers are able to judge whether MADS are generally applicable within these organisations and are able to enhance them to deliver support.*"

The result in this contribution is a qualitative set of criteria which considers the aspects in the engineering design transformation system. These results have to be used in the early stages of the enhancement process of the ProKon system.

3 RESEARCH METHODS

The research presented in this contribution is structured according to the guidelines of the DRM (Design Research Methodology) by Blessing and Chakrabarti (2009). Thus, the Research Clarification is explored in Sections 1, 2 and 3, in which a basic understanding of the problem and objectives is gained. In order to go deeper into the knowledge domain, Section 4, as the description of the state of the art, can be substituted by Descriptive Study I. There, analysis is required as to whether the goal stated in Section 2 has already been reached and the research question has not been sufficiently answered. As one important part of the literature analysis, it must be proven that the approach of Hubka and Eder (1996) is suitable for answering the research question. The Prescriptive Study is carried out within Section 5 by creating a set of criteria. With regard to the progress of the research, an evaluation is omitted (no Descriptive Study II). Nonetheless, general evaluation criteria will be discussed in Section 6 (compliance with requirements, consistency, insularity, applicability, usefulness and success). Finally, this contribution will be summarised and an outlook will be given (Section 7).

4 STATE OF THE ART

In this section, important questions have to be answered to form a basis for the approach presented. Firstly, the question of "Which relations exist between IS and organisations?" is answered in Section 4.1. Secondly, the answer to the question of "Which criteria for analysing organisations exist so far?" gives a solid foundation for the own creation of criteria (Section 4.2). Thirdly, in Section 4.3 the approach of Hubka and Eder (1996) is described.

4.1 Relation between IT and organisation

Formulated as a hypothesis, Figure 2 shows that the organisation determines the enhancement process and thus the ProKon system itself. To verify this hypothesis, general relations between IS and organisations have to be examined. Markus and Robey (1988) postulate three interdependencies: Technological imperative, organisational imperative and emergent perspective.

The technological imperative is strongly determined by the impact that an IS has on an organisation. Individuals and the organisation itself are constrained by the use of the system. The organisational imperative is rather different. "This perspective holds that human actors design IS to satisfy organizational needs for information." (Markus and Robey, 1998, pp. 587) Thus, the IS is dependent on what the organisation needs (e.g. support of processes) and has to be subsequently modified. Related to the complexity in modern organisations, the emergent perspective considers complex social interactions between decision makers behind the IS and people in the organisation. Therefore, it is difficult to state which side (system or organisation) is mainly influencing the other side and which is just dependent (Markus and Robey, 1998).

4.2 Existing criteria for analysing organisations

In this subsection, the state of the art is analysed to gather already existing. These criteria were used to analyse organisations in order to subsequently judge whether IS in general and KBE systems can be developed/enhanced and finally integrated as intended. Moreover, some criteria stem from areas which do not have a thematic link to analysing organisations. To finalise the analysis, existing criteria of the (meta) literature study by Doan et al. (2011) are included. The results of the literature review are shown in Table 1.

Table 1. Overview of already existing criteria according to the state of the art

Point	Criterion	Reference
A	Composition of the team in the organisation	Eppler et al. (1999)
B	Return on investment	Inter alia Emberey et al. (2007)
C	Handling of faults in the organisation	Lindemann (2005)
D	Willingness to change	Lindemann (2005)
E	Appearance of a culture of knowledge (includes a knowledge retention strategy and a learning culture)	Doan et al. (2011), Sollberger (2006)
F	Appearance of a specific organisational culture	Heisig (2005)
G	Routine steps in the engineering design process (EDP)	Emberey et al. (2007)
H	Complexity of the EDP	Emberey et al. (2007), Remus (2002), van der Welden et al. (2012
I	Appearance of iterations in the EDP	Emberey et al. (2007)
J	Possibility of formalising the EDP	Emberey et al. (2007)
K	Lead time of the EDP	Emberey et al. (2007)
L	Parallelism of process steps (PS) within the EDP	Lander (1997)
M	PS not yet covered in the EDP by means of IS	Eppler et al. (1999), Heisig (2005)
N	Knowledge intensity of the EDP	Eppler et al. (1999), Remus (2002)
O	Commitment of the actors and stakeholders (e.g. top management support)	Doan et al. (2011), Schreiber et al. (2002), Stokes (2001)

P	Available resources (time, budget, staff, etc.)	Schreiber et al. (2002), Stokes (2001)
Q	Consideration of similar systems (i.e. information and communication technology, ICT)	Doan et al. (2011), van der Welden et al. (2012)
R	Applications with distributive and cooperative characteristics	Parunak (1998)
S	Applications with initially undefined conditions and changeable conditions during the running time	Parunak (1998)

As an example to clarify what is meant by a specific criterion and how it has to be used, the "Parallelism of process steps within the engineering design process" is picked up (Point L, Table 1). Lander (1997) states that MADS are only functional if there is a certain parallelism of process steps which are executed by agents. Of course, ultimately it must be defined what is precisely meant by "a certain parallelism". Are five process steps in parallel enough or does it depend on the number of agents within the agent system? This problem has to be precisely solved in this research for all other criteria. On the one hand, it is remarkable that Emberey et al. (2007) and Lander (1997) focus on the engineering design process itself. On the other hand, it is interesting that Sollberger (2006) and Heisig (2005), for example, also consider rather soft factors like culture of knowledge (e.g. willingness to learn in the organisation) and organisational culture. Moreover, economic criteria (e.g. return on investment) appear in literature and serve as a supplement to purely technical and organisational aspects. As a summary of this subsection, it can be stated that technical, organisational, personal and economic criteria have to be used to judge whether an IS can be developed/enhanced for subsequent integration into the organisation.

4.3 Analysis of the design engineering transformation system

As suggested in the hypothesis, the design engineering transformation system by Hubka and Eder (1996) is used in order to create a certain relevance for the own approach. Both authors deal primarily with design theory and have developed the design engineering transformation system which consists of the following five aspects: engineering design process, engineering design knowledge, technical system, design engineer and management of design processes (see Figure 3). The operators are aspects which influence the process (operand) through the transformation task. The reason why this approach is taken is the assumption that it covers all domains which have to be analysed by the knowledge engineer concerning the engineering design department. Consequently, this approach creates a defined relevance and insularity so as to avoid omission of something to be analysed.

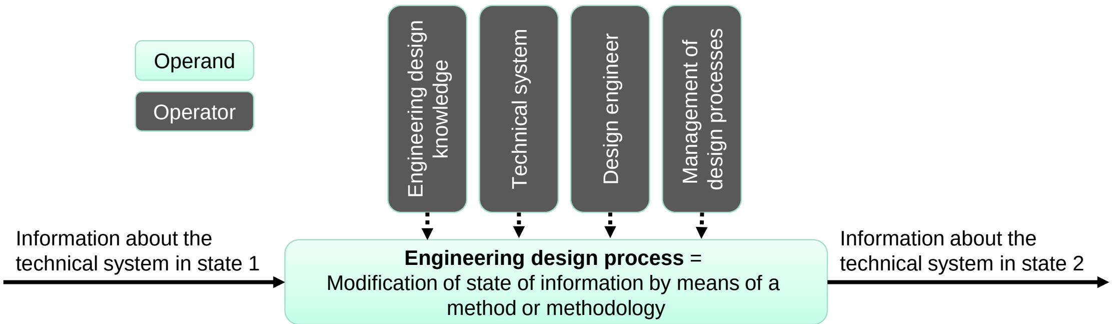

Figure 3. The design engineering transformation system (Hubka and Eder, 1996)

5 SYSTEMATIC ANALYSIS OF ORGANISATIONS

After analysing the state of the art, this section deals with the actual content of this contribution. Firstly, the general approach is described, which is based on the design engineering transformation system described in Subsection 4.3. Secondly, the set of criteria is derived, which serves as a guideline for knowledge engineers to recognise what has to be analysed in detail in an organisation.

5.1 General approach

The general approach is based on the design engineering transformation system with its five aspects (cf. Figure 3). In line with the hypothesis stated in Section 2, these aspects have to be considered when analysing the organisation. If all aspects have to be considered correctly and the ProKon system

delivers support to the organisation, success has to be achieved. Consequently, in the following these aspects are called “success factors”.
Bearing in mind Figure 3, however, not all aspects are suitable for forming success factors. Therefore, the transformation system has to be slightly rearranged and modified. Firstly, the engineering design knowledge has to be considered only implicitly due to the assumption that it is incorporated within all other operands and in the operator. This leads to a reduction in the number of aspects from five to four. Secondly, by considering points O and P in Table 1 for example, it is important to additionally analyse the infrastructure of the organisation, which is not included in the existing aspects. Before the actual enhancement of the ProKon system can take place, it must be clarified whether there are IS within the organisation which already satisfy the functions the ProKon system is intended to perform. If this is the case, the enhancement of the ProKon system must either be cancelled, the functionality sectioned or the functionality of the ProKon system enlarged. Moreover, IS currently in planning must also be considered. According to Heisig (2005), both sides (current IS and planned IS) should be integrated into the analysis. Finally, the following success factors could be named. With regard to successful enhancement of the ProKon system and integration into the organisation, the organisation has to have …

- … a particular culture and infrastructure. ↔ Environment of the organisation (formerly management of design processes)
- … a particular type of engineering design process. ↔ Engineering design process
- … a particular type of design engineer. ↔ Design engineer
- … a particular type of design object. ↔ Technical system

In general, the success factors represent the areas of analysis in the organisation. However, they are still not applicable due to the fact that knowledge engineers do not know what to ask and who to ask. Therefore, the success factors are broken down into a qualitative set of criteria which describe each success factor more precisely. Some criteria (e.g. culture of knowledge) may still not be applicable because they need indicators to rigorously measure them. Finally, a set of operationalised questions is available to support knowledge engineers. In order to offer support to the knowledge engineer who analyses the organisation, the success factors, the criteria and the operationalised questions have to be embedded in a process which is in turn part of the enhancement process (cf. Figure 2 and Figure 4). In general, bearing in mind the three possible relations between IS and organisation, the relation between the ProKon system and the organisation is represented by the organisational imperative, due to the fact that most organisations do not want to modify themselves in order to be supported by an IS. Thus, the organisation determines how the ProKon system has to be enhanced and integrated.

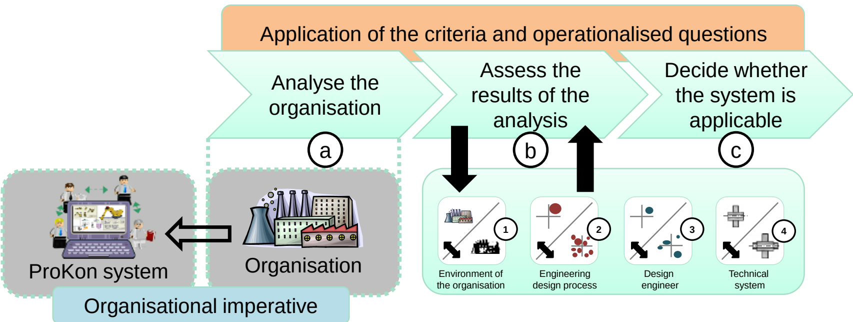

Figure 4. General procedure for deciding whether IS are applicable

In a first step (see Figure 4, a), the organisation is analysed by observation and by interviewing the relevant persons. This is done by the knowledge engineer who firstly has to identify them in the organisation. First reflections about the set of criteria have shown that it is important in which order the success factors have to be analysed. First, the environment of the organisation has to be analysed because of the fact that this success factor consists of general criteria. For instance, the culture of knowledge (e.g. handling of faults in the organisation, cf. Table 1) can be answered on a higher level within the success factor “environment of the organisation” and also on a lower level concerning a particular design engineer in the department (see Figure 4, 1). However, before asking a particular “design engineer”, it is necessary to decide which one has to be asked. This is done in the selection of the engineering design process to be supported by the ProKon system (2). Thus, the process has to be analysed before the design engineer and after the environment of the organisation (3). Finally, the technical system is analysed which is also dependent on the engineering design process (4). In the second step (see Figure 4, b), a multidisciplinary team consisting of the knowledge engineer and, for example, method developers in the field of PLM, design managers and design engineers is build up. The knowledge engineer presents the result of the analysis. In consultation with the team, these results are assessed by comparing the capabilities of the organisation (i.e. the result of the analysis) with the capabilities of the ProKon system. By means of the heterogeneity of this team, different backgrounds deliver a more sounded assessment. Especially, specific KO criteria are relevant, which have to be fulfilled in any case. All other criteria need to be balanced to produce a shared meaning over the team. In the third step (c), the multidisciplinary team supports the knowledge engineer in order to make a decision as to whether the IS is applicable, and if so, how this system needs to be enhanced.

5.2 Criteria

The success factors introduced in Section 5.1 build the framework but they are not really applicable for the purpose of this contribution. This is expressed, among other things, by the term “particular” within the description of the success factors (see list in Section 5.1). Due to this reason, these success factors have to be further concretised in line with the predefined criteria in Section 4.2. These criteria from the state of the art (see Table 1) were first analysed and then discussed with experts in practice (one manager, one junior design engineer and one psychologist in the automobile industry) and research (three junior scientists in IS research). This is considered to be as an a priori evaluation. With Table 1 in mind and considering the discussions with the experts in practice, Table 2 gives an overview of the resulting criteria for analysing organisations. Each criterion is assigned to one success factor (cf. Section 5.1) and assigned to the choice whether it is a KO criterion. A KO criterion is a criterion which has to be fulfilled by the organisation in order to adequately enhance the ProKon system and integrate it into the organisation (i.e. a “must” criterion).

Table 2. Overview of the criteria with corresponding success factors (= SF), KO description, reference to the points in Table 1 and considering the discussions with experts in practice (cf. “Origin” in table heading)

No.	Criterion	SF	KO?	Origin
1	Existence of the “right” employees in the organisation	Environment of the organisation	yes	cf. A and P
2	Sufficient temporal resources		yes	cf. P
3	Sufficient monetary resources		yes	cf. P
4	Comparison of managers’ requirements with the functionality of the MADS		no	cf. O
5	Managers’ target system		no	cf. O and from discussions
6	Predominant culture of cooperation in the organisation		no	cf. E and F
7	Handling of faults in the organisation		no	cf. C and E
8	Possibility of working autonomously in the organisation		no	cf. E as elements of the culture of knowledge
9	Predominant willingness to learn in the organisation		no	
10	General motivation in the organisation to pass on knowledge		no	
11	Possibility of falling back on existing documents to accelerate enhancement of the MADS		no	from discussions
12	Usage of the “right” CAD system	Engineering design process	yes	cf. Q and from discussions
13	Expected saving potential of the target engineering design process in terms of costs and time		yes	cf. B and K
14	Possibility of expressively modelling the engineering design process (EDP)		yes	cf. J
15	Comparison of the functionalities of the MADS with the functionalities of existing or planned IS considering the EDP		yes	cf. M and Q
16	Addressing of the fundamental problem which has to be solved by the MADS		yes	from discussions
17	Usage of the “right” calculation program for machine elements		no	from discussions
18	Recognition of a parallel application within the EDP		no	cf. L

19	Recognition of a distributed application within the EDP		no	cf. R
20	Recognition of a cooperative application within the EDP		no	cf. R
21	Recognition of an application with initially incomplete defined boundary conditions within the EDP		no	cf. S
22	Recognition of a structurally changeable application within the EDP		no	cf. I and S
23	Knowledge complexity and knowledge intensity of the EDP		no	cf. G, H and N
24	Number of roles in the EDP (e.g. material expert)		no	from discussions
25	Expected height of saving potential of the target EDP in terms of costs and time (cf. criterion 12)		no	cf. B and K
26	Professional experience of relevant design engineers (DE) occupied with the EDP	Design engineer	no	from discussions
27	Urgency of the support through the MADS		no	cf. D and from discussions
28	Recognition of a modular digital product model (DPM)	Technical system	yes	cf. S
29	Expected saving potential of the target technical system in terms of costs and time		no	cf. B
30	Level of complexity of the target technical system		no	from discussions
31	Recognition of not initially defined elements within the DPM		no	cf. S
32	Existence of so-called meta models to describe the target technical system in an understandable way for agents		no	from discussions

As a summary, some criteria in Table 2 are not sufficiently concrete to enable knowledge engineers to analyse organisations (e.g. No. 21 and 22). These criteria have to be broken down into questions to identify the issue. In contrast, criterion No. 12 does not have to be made more applicable because this criterion can surely be understood by knowledge engineers. In the following, criterion No. 22 will be broken down into single questions to elucidate the problem of lacking applicability. Therefore, it has to be separated into three questions which have to be understandable. Table 3 lists these questions and the overall question. Knowledge engineers have to answer the single questions (22.1-22.3) and if they can confirm a minimum of two questions then criterion No. 22 is also confirmed.

Table 3. Criterion No. 22 with detailed questions

No.	**Question**
22.1	Can requirements regarding the solution be changed during the runtime of the system?
22.2	Can boundary conditions be changed during the runtime of the system?
22.3	Can the system environment be changed during the runtime of the system?
∑22	Can a structurally changeable application in the engineering design process be recognised?

In conclusion, a total of 74 questions were derived from the set of criteria in Table 2, whereby 16 criteria do not require further concretisation.

6 DISCUSSION OF THE RESULTS

First of all, keeping the objective of this contribution in mind, it can be stated that the existing set of criteria has been enlarged (cf. Table 1 and Table 2). Thus, a particular level of originality is achieved, being aware of the fact that this might not be sufficient to deliver support to knowledge engineers in practice. Therefore, a couple of tasks need to be performed. A subsequent step is the evaluation of all criteria and questions in terms of usability in real application scenarios. This is considered to be as an a posteriori evaluation. Although the set of criteria has been discussed with some experts from the automotive industry and IS research, the conclusion that the set of criteria is applicable is not permitted. Moreover, when considering the previously mentioned evaluation criteria from Blessing and Chakrabarti (2009) (compliance with requirements, consistency, insularity, applicability, usefulness and success) the following statements could be given. The basic requirements (e.g. relevant criteria with certain insularity) were considered within the approach in this contribution. In the first instance, relevance, consistency and insularity is ensured through the discussion with the experts. Due to the lack of application in industry, usefulness and success could not be proven. However, the research question as stated in Section 2 was answered by means of the approach of Hubka and Eder (1996). It seems that this approach is an appropriate way to structure the set of criteria and achieve a certain level of relevance. The question of whether the hypothesis is generally verified can only be answered through evaluating the results of this contribution. A first critique has to be inferred from the selection of the underlying approach (here: design engineering transformation system). Although the approach seems to be suitable, there are certainly a couple of other approaches which also verify the hypothesis and are perhaps more functional. An example of another approach is the reference model for open distributed processing (RM-ODP) published by ISO 10746 (2009). This standard contains five viewpoints of which only one viewpoint (the enterprise viewpoint) covers one aspect of the chosen approach in this paper (the environment of the organisation). However, research is mostly founded on certain axioms which are defined as true, neglecting other possibilities. Furthermore, discussion is required as to whether the selection of the organisational imperative is correct. By considering the real world with mutual dependencies between IS and organisations and therefore a high level of complexity, the emergent perspective is perhaps the better way. However, it is questionable whether this selection is decisive for the analysis of IS and organisations. In any case, the technological imperative is not the best choice and should not be generally applied in practice. Moreover, discussion is needed as to why just a qualitative set of criteria is created. At the current stage of the project, a quantitative result is not achievable because of the fact that it is too difficult to measure characteristics of organisations using quantifiable values relating to the culture of knowledge, for example. Verhagen et al. (2012) state that alone the focus on criteria is more important than measuring them quantitatively. Moreover, knowledge engineers should gain an initial feeling about the situation based on which they can decide. Finally, the chosen inductive approach has to be discussed. In this contribution, the focus is on the ProKon system and the results are generalised in terms of MADS. This has to be done in this way, but evidence has to be provided to the effect that knowledge engineers are supported by the results of this contribution in their analysis of organisations with regard to development/enhancement and the integration of MADS in general.

7 SUMMARY AND OUTLOOK

In this contribution, an approach is presented for delivering support to knowledge engineers so that they are able to analyse organisations to judge whether a MADS can offer reasonable support to organisations with regard to the design process. In contrast to the studies of Ermine et al. (2006) with their knowledge maps and Grundstein et al. (2003) with their GAMETH procedure, the objective of this paper is not to analyse knowledge in the early stages of developing IS. Analysing and representing knowledge is only necessary if the IS is suitable for the specific organisation. An analysis of the state of the art is followed by a description of the own approach. This approach is based on classical design theory and deals with the engineering design process as the central operand. As the foundation, four success factors (engineering design process, design engineers, technical system and environment of the organisation) were derived in order to forecast successful application of the MADS in the organisation. After that, 32 criteria were derived from the four success factors which were in turn operationalised with 74 questions to really support knowledge engineers. Finally, success factors, the set of criteria and the operationalised questions represent the support for knowledge engineers to give a certain awareness of whether the system can support the organisation. All three are arranged within a process of analysis and decision making.

In the future, the whole support aspect has to be evaluated a posteriori in terms of application in industry. Here, it should be tested whether it is possible to perform such an analysis at all. The set of criteria and the questions may be too complex for the purposes of analysing organisations. Therefore, the characteristics of success may have to be concretised. Another focus lies on the proper integration of the system into the procedure of enhancing a MADS (cf. Figure 2).

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