KNOWLEDGE MANAGEMENT AT INDIVIDUAL LEVEL TO SUPPORT LOGISTICS PROBLEM SOLVING[1]

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Summary

Logistics problem solving is a knowledge-intensive process which usually requires a large amount of experience with the problem-solving person. Consequently, a proper management of this knowledge and experience at individual level is a chance and a challenge for improving a person's problem-solving capability. Against this background the paper aims to help knowledge in becoming productive within logistics problem-solving processes. Based upon the statement by logistics company managers characterising knowledge as a key resource in their processes that mainly evolves through projects, the paper identifies logistics projects as problem solving processes and specifies the type of problems logistics has to deal with. Further on, chances from applying knowledge management approaches in logistics problem solving are discussed to answer questions for (i) how to encourage and support persons to bring in their knowledge including to raise awareness of the knowledge they have already, (ii) how to mediate between different types of knowledge stakeholders and repositories, and (iii) how to enable and support the access to and use of knowledge. This is illustrated by examples from logistics simulation projects where simulation models are to be seen as knowledge repository and an intelligent human-computer dialogue is required for accessing this knowledge.

Key words: *knowledge management, problem solving, logistics simulation, knowledge repository, knowledge sharing.*

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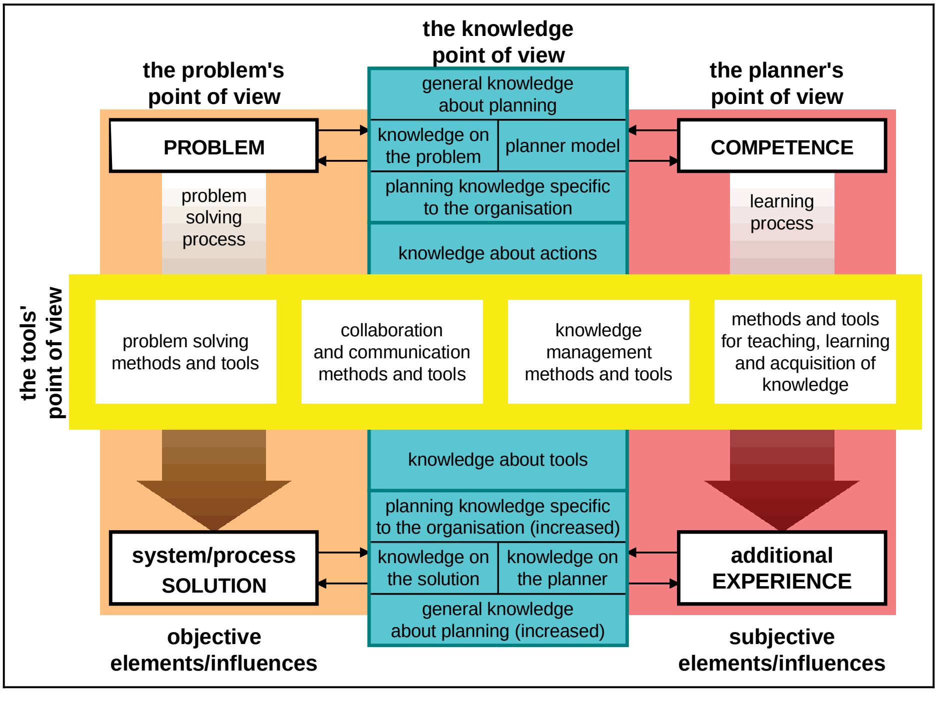
1.INTRODUCTION AND MOTIVATION

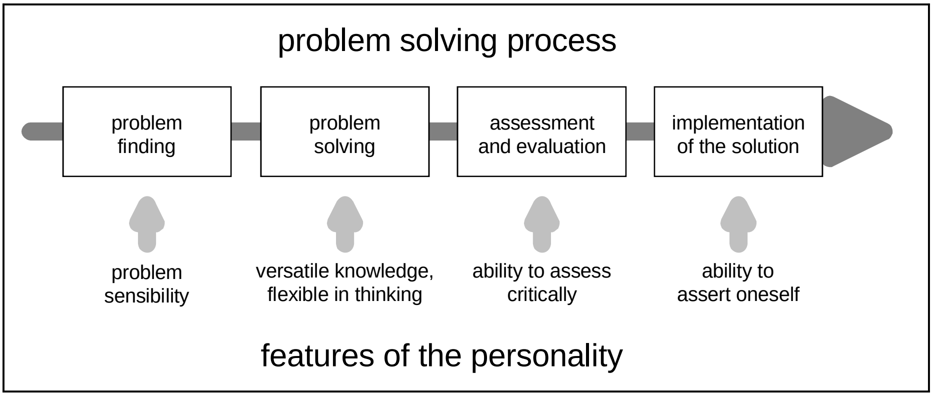
In general, knowledge management describes the conscious, systematic and strategically anchored handling of knowledge considering people, organization and technology in order to encourage individual, social and organizational learning processes (Reinmann-Rothmeier et al. 2001). Whereas knowledge management is typically discussed as organizational matter, this paper focuses on the application of knowledge management concepts, methods and approaches at personal level. More specifically the challenge consists in managing a person's knowledge in a way unlocking its developmental potential and giving it value. In order to transform knowledge into a valuable organizational (or individual) asset, knowledge management aims at formalizing and accessing experience, knowledge, and expertise that create new capabilities, enable superior performance, encourage innovation, and enhance customer value (Beckman 1999). For this, knowledge management provides a wide variety of methods and tools for creating and acquiring, storing and retrieving, exchanging, or using and re-using knowledge as a strategic resource. Here, knowledge is generally defined as reasoning about information and data to actively enable performance, problem-solving, decision-making, learning, and teaching (Beckman 1999).

Figure 1: Influences and spheres of logistics problem solving exemplarily related to logistics planning



There is no doubt about the fact that problem solving is a knowledge-intensive piece of brain work. On one hand problem solving – especially successful, efficient, effective problem solving – requires to bring in and apply general and domain-specific knowledge the problem-solving person has gained from learning, but also from problem-solving experience. On the other hand each problem-solving process also is a knowledge-creating process as new knowledge grows from understanding the problem and its sources, from finding a suitable or the best solution to this problem and from choosing the right method(s) or tool(s) and correctly applying it (them) in a certain problem-solving step (see Figure 1). The amount, type and level of knowledge required to solve a particular problem and acquired from dealing with it depends on both the problem's degree of difficulty and complexity and the level of knowledge and experience the problem-solving person has. Therefore, each problem is settled down in and linked to a certain domain (objective component) and depends on the problem solving person's background (subjective component). The latter particularly can be characterized by the individual competences in identifying the problem, choosing a suitable problem-solving path, applying appropriate methods and tools, evaluating candidate solutions and self-reflecting the problem-solving process as run through in order to derive experiences gained and lessons learned (see Figure 2).

Figure 2: Problem-solving steps and problem-solving personality



Consequently, knowledge management is expected to provide a tremendous contribution to the improvement of problem solving capability. To learn from previous experience, to know about valuable experts, their location and expertise for getting them involved in running projects or new tasks, to better understand pre-conditions, settings and decisions from the past and with relevance to today's activities, to easily identify and get access to the right knowledge exactly when it is needed – these are sources for increasing a person's, a team's or an organization's problem-solving competence and performance. Despite of this understanding and although problem-solving and knowledge management methods and tools are available in growing amount and more and more easy-accessing way, the developmental potential of knowledge in problem solving is often not recognised and remains locked in the different types of (potential) knowledge sources. Adopting a statement on human needs for computer technology by Shneiderman (2002) the link between knowledge management and problem solving can generally be described as follows: the old discussion about how to support problem solving is about what (knowledge management) tools can do; the new discussion about how to support problem solving is (and must be) about what kind of problem-solving support people really need.

Against this background the paper discusses needs and chances for knowledge-based and knowledge-focussed support to problem solving particularly with regard to challenges in a complex problem scenario. Here, logistics is being used as application area as logistics problems are quite often of very complex nature leading to challenging problem-solving processes with always new, multi-step procedures and the need for a variety of methods and tools. In addition to this, logistics problem solving requires the ability to operate in an ill-structured situation. The following sections will introduce into problems and problem solving in logistics (Section 2), before approaches for unlocking the developmental potential of knowledge in logistics problem solving are discussed. For this, logistics simulation projects are used as examples to illustrate how internal knowledge from methods, models and solutions can be accessed (Section 3), how the use of knowledge for purposeful experimentation might be supported (Section 4), and how existent knowledge might be distributed through knowledge exchange and stakeholder development (Section5). Section 6 summarizes discussions and draws conclusions on barriers and chances for helping knowledge in becoming productive.

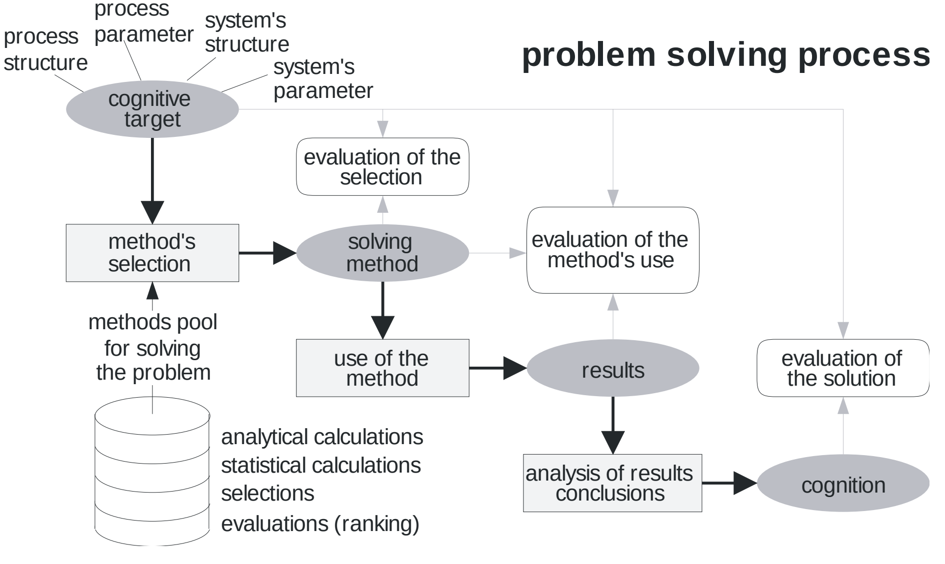
2. PROBLEMS AND PROBLEM SOLVING IN LOGISTICS

In general, a person faces a problem when a current situation is not satisfying, but for some reasons it momentarily cannot be changed into a desired one. Due to the complicated structure of potential solutions, problems related to logistics planning and operation but also corresponding problem-solving processes are of complex nature. They are subject to a variety of influences, demands and circumstances entailing steps to configure, dimension or evaluate in dependence on what is given and what has to be defined. According to this, four classes of problems of increasing level of difficulty and complexity can be identified:

- *Tasks* are challenges that require applying known methods within a clearly defined procedure in order to change a well-structured current situation into a known target situation. The problem-solving person has all knowledge and competence necessary to understand the problem and got for the solution.
- *Interpolation problems* are characterized by an unknown procedure for how to deal with them although current as well as target situations are known and a collection of problem-solving methods (or tools) is available. Here, analytical thinking is required by the problem-solving person in order to find a suitable way to come from the problem to the solution by purposefully applying the methods.

- For *synthesis problems* both, methods/tools and problem-solving path, are unknown and the current situation might be ill-structured. The problem-solving person has just a clear idea and understanding of the target situation, i.e. s/he knows where s/he wants to go to. To get there mainly creative thinking is required in order to understand the current situation, select appropriate methods and find a working procedure for solving the problem.
- *Dialectic problems* form the most challenging type of problems. Here, neither current nor target situations are clearly defined and neither methods nor a procedure solving the problem are known. Therefore, the problem-solving person must combine analytical and creative thinking capabilities in order to approach and find a solution.

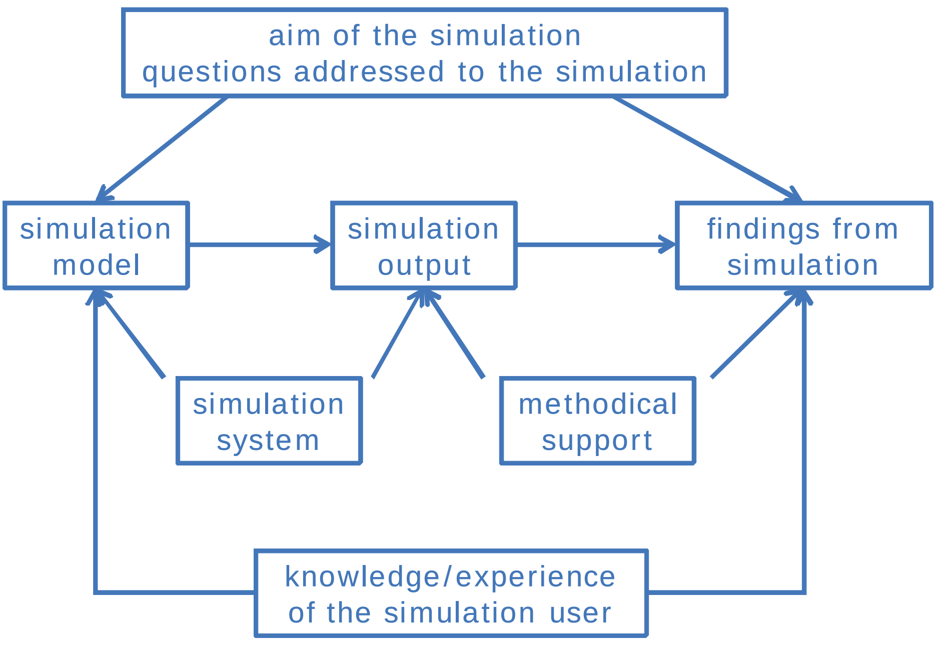
Figure 3: Steps and challenges in the problem solving process



Logistics problems might belong to any of those classes – depending on the situation and on the person's level of knowledge, competence and experience. That is why logistics problem solving typically can be characterised as a phased process of loops, as a process developing variants for and versions of both the logistics process and the logistics system. Analysing steps and creative, evaluating steps for synthesis with partially changing cognitive problems and views take turns. As a rule searching for appropriate and suitable components for solving the problem comes first. After that the defined components must be rendered consistent with one another in order for the over-all functionality as given in the problem specification to be realised. Methods available for this process are many and diverse; they are selected according to the type of problem (i.e. design, decision-making, parameter-setting, selection, and evaluation), the current state-of-the-solution and available input data and information. The stock of methods includes simple deterministic as well as complicated stochastic calculation models in the form of analytical formulae and extends as far as simulation models (see Figure 3). Applying the appropriate method in the right way brings out results which need to be analysed to derive findings that match the identified target or in other words solves the initial problem. But apart from the challenge of method selection and application another challenge consists in dealing with a dynamically changing environment logistics problem-solving is embedded in. Time pressure and limitation of resources define restrictions to be taken into consideration. Even at an early planning stage and on the basis of little information only, a maximum of reliability and quality must be reached with minimal effort and in minimal time. In the end the challenge usually does not consist in searching for the optimal solution in theory, but for an appropriate, practicable and realizable one which solves the identified problem properly and efficiently.

Within these constraints discrete event simulation is in many cases an appropriate method and tool allowing the chronological reproduction of real processes and systems realistically and accurately in any detail. Processes can safely be shown and speeded up; they are as repeatable and variable as desired. Pre-condition for this is an appropriate, valid simulation model representing an existing or planned logistics solution at the required level of detail. Input data such as time parameters, other quantitative parameters or process rules are either obtained from analysing real systems (for

Figure 4: Impact of the simulation user on the outcome of a simulation project



modelling an existing system) or derived from settings and expert assumptions (when modelling a planned system). Purposeful experimentation with the model produces a wide variety of output data that need to be transferred into results by context-sensitive and problem-specific interpretation on the basis of statistical compression and graphical representations. Additionally, results can clearly be visualized by means of animation which supports model validation, experimentation, understanding of output and presentation of results to the same extent. Simulation methodology is to be applied to logistics problem solving whenever in reality not (yet) extant logistics systems or contexts are to be investigated, cause-effect chains are highly complex in nature, future or visionary scenarios are to be observed, alternative design variants are to be analysed, or a long-term analysis of system behaviour needs to be run.

Due to its prominent role in logistics problem solving logistics simulation is used as example to discuss and demonstrate the needs and chance for knowledge-based support. This is even more useful as one of today's challenges regarding simulation consists in seeing it in the context of human-centred processes. This requires understanding simulation as a complex problem-solving, knowledge-generation and learning process but simultaneously as a tool to support teaching and as the subject of knowledge application. Furthermore, human resources involved in a simulation project are the key factors for its success and efficiency. As shown in Figure 4 the simulation user impacts the outcome of a simulation project in different ways and at different stages. The final appearance of a simulation model (being implemented by use of a particular simulation package in order to answer certain questions address to the simulation) strongly depends on the modelling experience and philosophy of the modelling person. Based upon this model and following the user's experimentation strategy simulation output is being produced, the interpretation and understanding of which again requires direct involvement of and input by the user.

The clue to the successful implementation of those knowledge management procedures is often an appropriate (supporting) environment and climate in the organization. Concerning this, there is a greater need for a cultural shift than for additional software tools and IT solutions. This is also confirmed by the results from a survey on the role of knowledge in logistics companies (see Neumann and Tomé 2006). Here, nearly all (of the not so many) respondents declared knowledge was a key resource for the company's performance: more than 75% of the responding companies (at least in the logistics managers' opinions) characterize knowledge management as supportive to all activities and helpful to better perform at the market; furthermore knowledge changes and improves all the time (in more than 60% of the cases) and/or develops with particular activities such as projects (in 50% of the cases). Consequently, it is worth to go into detail when discussing about how knowledge-based support can be provided to logistics problem-solving in general and logistics simulation in particular. For this typical knowledge management activities have been selected: accessing knowledge from a repository, using knowledge for planning, running and analysing experiments, and distributing knowledge through knowledge exchange and further development of knowledge stakeholders.

3. ACCESSING KNOWLEDGE: SIMULATION MODELS AS KNOWLEDGE REPOSITORIES

A simulation model is more than just a tool necessary to achieve certain objectives of experimentation and cognition. In the course of a simulation project the simulation model is developed, modified, used, evaluated and extended within an ongoing process. Therefore, it is also a kind of dynamic repository containing knowledge about parameters, causal relations and decision rules gathered through purposeful experiments. In the end, knowledge stored in the simulation model can be considered proven, independently of whether it was developed by the domain expert him- or herself or by a consultant simulation expert. Unfortunately, this knowledge is usually not very well documented and therefore does exist implicitly only inside the simulation model.

Knowledge represented by or stored in a simulation model is of both explicit and implicit natures. According to Nonaka and Takeuchi (1995) implicit or tacit knowledge is that kind of knowledge that a person carries in his or her mind often not even being aware of it, that the person cannot express and that is therefore not directly externalizable. It is typically based on experiences and expressed in the form of action patterns and feeling-based decisions. As a consequence the simulation model as the result of applying this implicit knowledge somehow carries at least parts of it without allowing direct access. Indirect access might eventually be possible via analyzing a person's model building and implementation behaviour and interpreting observations. This way of accessing simulation knowledge then is more a kind of knowledge explication strategy helping a person to recognize and discover him/herself intuitive decisions and actions. But this is difficult and very challenging if possible at all.

Instead, we want to focus on a more promising way to access simulation knowledge that is of explicit nature. Explicit knowledge is that kind of knowledge that exists independent of a person, e. g. in the form of any document. More precisely it is knowledge that has been or can be articulated, codified, stored and accessed by other persons. If not articulated yet, this knowledge is still carried by the person, but could be externalized by use of the right means. In case of simulation modeling this knowledge lays with the model building or implementing person and also with the developer of simulation software. It refers to modeling settings and assumptions like system boundaries and interaction with its environment, system elements and their links, their level of detail in representation, input data, probability distributions etc. And it also covers model implementation decisions, such as the simulation tool to be used, model components to be used, modeling tricks to be applied etc. To get access to this knowledge as finally represented by the simulation model structured documentation and documentation support are helpful, but there is also the need for understanding which knowledge is behind or inside the simulation tool used. On the other hand, explicit simulation knowledge might directly be available from the simulation model in the form of model structure and parameters or simulation parameters and eventually comments, annotations, speaking names of model components or variables etc. Therefore, it should be subject to automatic extraction into a project report or model description. In the end, both forms of explicit knowledge need to be put together specifying HOW does a simulation model look like in greater detail and relating it to WHY does it look like this.

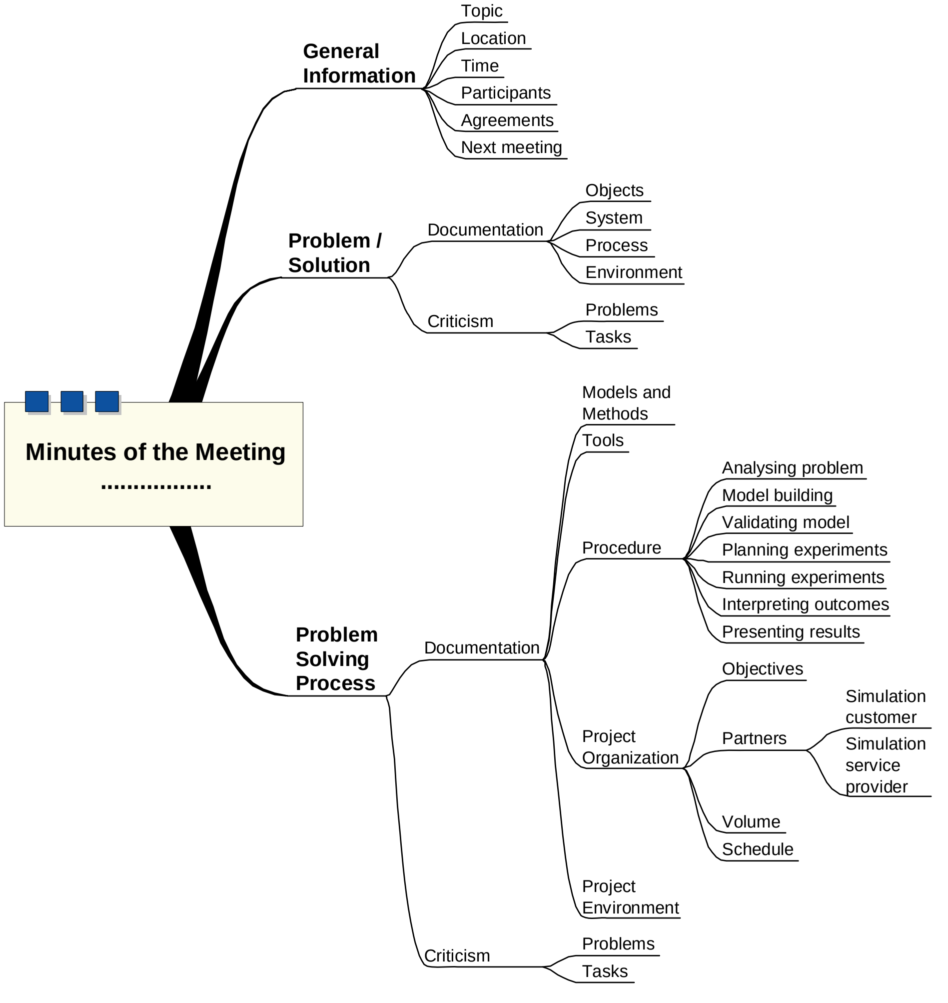
To access explicit knowledge stored in a simulation model that has been implemented by use of particular simulation software, it might be a good starting point to look at the conceptual model developed before. When this model has been represented in a formalized way and carefully validated, it correctly conceptualizes the system and processes to be modelled including components, dependencies and partly also parameters.

Thus, logistics simulation knowledge combines aspects from a wide variety of subjects and logistics simulation projects require a respective collection of interdisciplinary expertise. Furthermore, logistics simulation knowledge is dynamic and always evolves in the course of a project. That is why it has to be documented continuously and consequently. This requires a common and even formalizable documentation framework that is adjustable not just to the specific simulation problem, but especially to the current state-of-knowledge with each aspect and thus can simultaneously host descriptions of different levels-of-detail for different aspects.

The proposal for how such a documentation framework (in terms of both, structure and procedure) might look like is presented in Figure 5. Here, a simulation project meeting is used as example for specifying knowledge and input to be documented: apart from categories with typical information on a meeting, such as location, time, participants etc., this framework allows collecting detailed knowledge about the particular simulation project. For the latter, subject-related knowledge was clearly separated from procedure-related knowledge and individual sub-categories for both knowledge aspects have been defined. Following the basic structure of a viewpoint description each knowledge category contains documentation and criticism parts. Whereas the documentation part of procedure-related knowledge represents the main aspects of a simulation-based problem-solving process in general, the documentation part of the subject-related knowledge was specifically structured according to the application area of logistics. Consequently, on the first level it is further divided into object, system, process and environment categories which are suitable to completely describe a logistics or supply chain problem and solution. If the proposed documentation framework is to be applied to any other application area of simulation, this specific part would have to be adapted to the relevant elements of problems and their solutions in this particular area.

If in each project meeting one copy of this template is filled with the particular contents and results, a growing set of documents with structured simulation knowledge is produced. In addition to this, further documents, written or oral communication outside the meetings and further external knowledge sources used within the project can be analyzed in a similar way and thus increase the project-specific knowledge collection. From composing all of these individual documents step-by-step and according to project progress, a project-accompanying structured documentation of both the state-of-the-problem (and solution) and the state-of-the-problem-solving (including the state-of-development of the simulation model, methods and tools used or decisions taken) is derived.

Figure 5: Structure for documenting a simulation project meeting



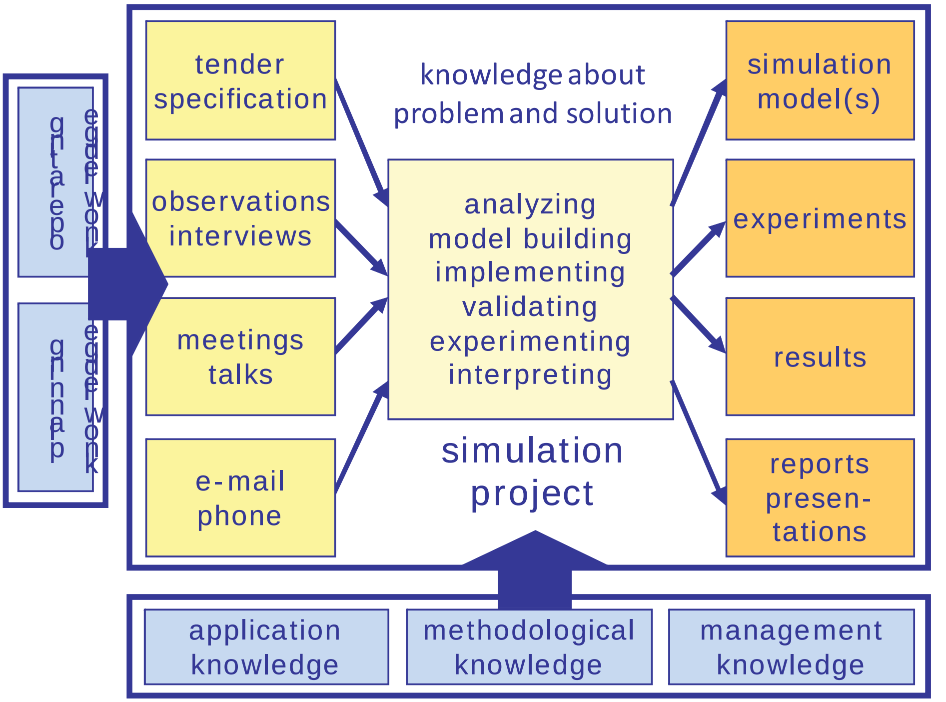
Source: *Neumann 2006*

At the same time the state-of-documentation resulting from each newly added source of knowledge also represents the particular state the project had reached at that point in time. With this, not only moment-specific representations of project knowledge, but also period-related representations of project progress become storable in a formalized way. Due to the fact that knowledge on the problem or solution and knowledge on the project procedure are always jointly documented, not only a purposeful reflection of taken decisions is required, but also a clear explanation of all modifications to the model, procedure or solution initiated by those decisions. Together with the corresponding files containing the simulation model this would principally allow to return to any point in the problem-solving process and continue from there towards a different path whenever this seems to be necessary or appropriate.

4. USING KNOWLEDGE: KNOWLEDGE-BASED EXPERIMENTATION

In general, input information for a simulation project usually come with the tender specification or are to be identified and generated in the problem definition and data collection phases of the simulation (Figure 6). Here, the user decides (and brings in) what is to be taken into consideration for model building and which information is required for the investigation.

Figure 6: Sources and evolution in simulation knowledge



Simulation experiments, for example, to support logistics planning and operation might be oriented towards modifications in either functionality or structure or parameters of a model and its components or even in a combination of those variations leading to more complex fields of experiments. To correctly interpret simulation output it is necessary to understand what the objectives, parameters and procedures of a certain series of experiments were and to relate this to the results and findings. Here, the simulation user faces the ever challenging task to interpret numerous and diverse data in a way being correct with respect to the underlying subject of the simulation study and directly meeting its context. These data are usually produced and more or less clearly presented by the simulation tool in the form of trace files, condensed statistics and performance measures derived from them, graphical representations or animation. Problems mainly consist in

1) clearly specifying questions the simulation customer needs to get answered,
2) purposefully choosing measures and selecting data enabling the simulation service provider to reply to the customer's questions, or
3) processing and interpreting data and measures according to the application area and simulation problem.

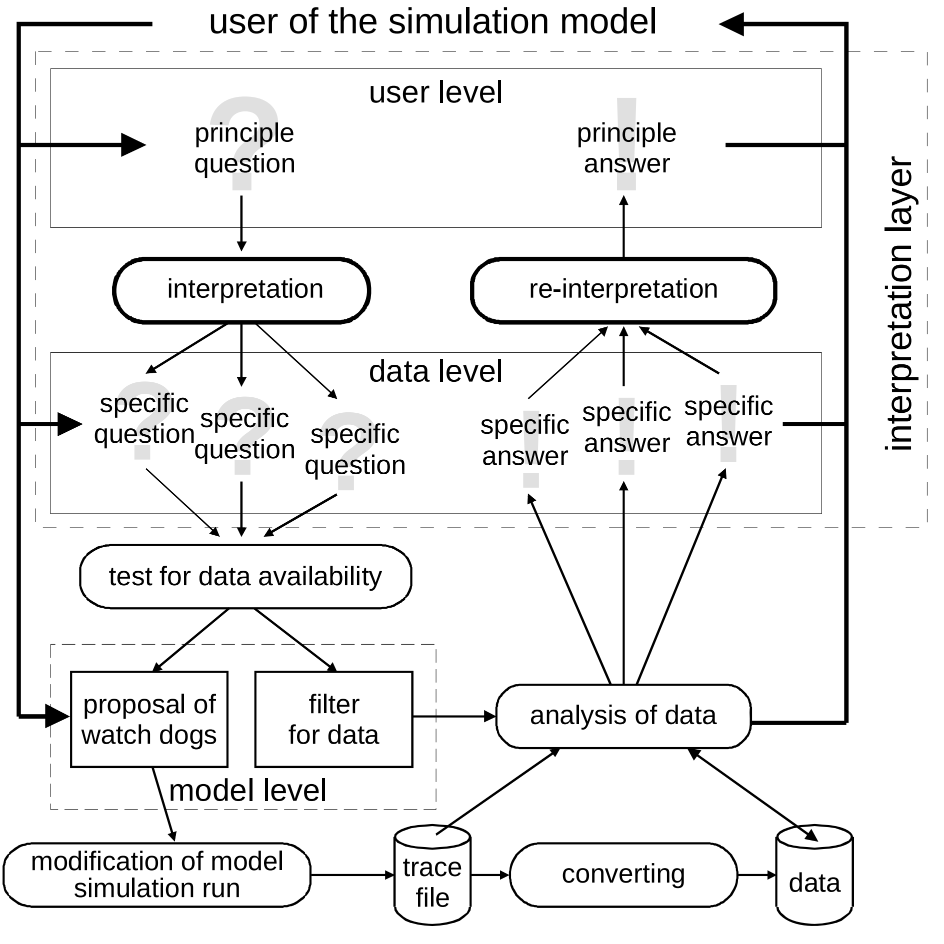
To overcome these problems and give support in defining simulation goals and understanding simulation results, methods and tools are required that are easy to use and able to mediate between knowledge and understanding of the simulation customer (the logistics expert planning or operating that process and system to be simulated) and the simulation expert (the expert from the point of view of data and their representation inside computers).

Within this context, it is worth thinking in more detail about what a simulation customer (the logistics expert) might look for when analyzing the outcome of simulation experiments (Neumann 2005):

- *Typical events*. The logistics expert specifically looks for moments at which a defined situation occurs. This kind of query can be related, for example, to the point in time at which the first or last or a specific object enters or leaves the system as a whole or an element in particular. Other enquiry might be oriented towards identifying the moment when a particular state or combination of states is reached or conditions change as defined.
- *Typical phases*. The logistics expert is especially interested in periods characterized by a particular situation. In this case s/he asks for the duration of the warm-up period, for the period of time the system, an element or object is in a particular state, or how long a change of state takes.
- *Statements*. The logistics expert looks for the global characteristics of processes, system dynamics or object flows such as process type (e.g. steady-state, seasonal changes, terminating/ non-terminating), performance parameters of resources (e.g. throughput, utilization, availability), parameters of object flows (e.g. mix of sorts, inter-arrival times, processing times). This information is usually based on statistics resulting from trace file analysis and replies to either a specific or more general enquiry by the user.

When the potential interests of a simulation customer as explained above are compared, one significant difference emerges: whereas the first two aspects need specific questions formulated by the logistics expert directly at data level, the last aspect is characterized by usually fuzzy questions of principle from the more global user's point of view. Before these questions of principle can be answered, they have to be transferred to the data level by explaining them in detail and putting them in terms of concrete data (Figure 7).

Figure 7: User-data interaction for simulation output analysis



As result of this process of interpretation a set of specific questions is defined with each of them providing a specific part of the overall answer in which the user is interested. Questions at data level correspond to results that can be delivered directly by the simulation even if minor modifications to the simulation model should be required. To derive an answer in principle to a question of principle the respective set of specific answers needs to be processed further. These steps of additional analysis and condensing can be understood as a process of re-interpretation to transfer results from data to user level.

All steps of interpretation and re-interpretation aim to link the user's (logistics expert's) point of view to that of the simulation expert. They not only require an appropriate procedure, but, even more importantly, an interpretative model representing the application area in which simulation takes place. This model needs to be based on knowledge and rules expressed in the user's individual expertise, but also in generalized knowledge of the (logistics) organization regarding design constraints or system behaviour and the experience of the simulation expert derived from prior simulations. As this knowledge might not only be of explicit nature but also comprise implicit or tacit knowledge simulation users as individuals or team need to remain involved in the steps of interpretation and re-interpretation at least. Whereas explicit knowledge might be transferred into rules and algorithms, tacit knowledge cannot be separated from its owner and therefore requires direct involvement of the knowledge holder in the interpretation process. More specifically this means support is required for translating any question of principle into corresponding specific (data-related) questions as well as for deriving answers of principle from a number of specific (data-related) answers. Although a set of (standard) translation rules might be known, formalized and put into the rule base already, always further questions remain that are unknown to the rule base yet. Here, the logistics expert needs support in (i) correctly formulating the right question and (ii) getting the full picture from the puzzle of available data and their analysis.

One approach for enabling this could be based on viewpoint descriptions. Viewpoint descriptions were introduced into model validation as a new kind of communication and interaction between the human observer of simulation results and the computer as the simulation model using authority that was called oracle-based model modification (Helms and Strothotte 1992). Here, the principle idea is that the user presents his or her observations (in the animation) as a viewpoint description to the computer that initiates a reasoning process. This results in definition and realization of necessary changes to the simulation model in an ongoing user-computer dialogue. The main advantage of this concept lies in the reduced requirements for rule-base definition. Those aspects that easily can be formalized (e.g. typical quantitative observations or unambiguous logical dependencies) are translated into questions to the user (What is it s/he is interested in?) or various forms of result presentation (as figures or diagrams), whereas those that are non-imaginable yet or individual to the user or simply hard to formalize need not to be included to provide meaningful support to the user. There is no need to completely specify all possible situations, views and problems in advance, because the person who deals with simulation output brings in additional knowledge, experience and creativity for coping with non-standard challenges. Even further, this way the rule-base continuously grows as it "learns" from all applications and especially from those that were not involved yet. On the other side the user benefits from prior experience and knowledge represented in the computer by receiving hints on what to look at based upon questions other users had asked or which were of interest in earlier investigations.

This approach helps in designing the interpretation layer for mediating between simulation customer and simulation model or output no matter how many data have been gathered and how big the trace file grew. As discussed simulation results derived from running experiments by use of a particular simulation model are as good as they finally respond to the questions the simulation user is interested in. The challenge consists in knowing about questions a user in a specific project might have. Generally, a certain amount of (standard) questions can be pre-defined in correspondence with the application area and another set of questions might be defined by the user when starting into simulation modelling and experimentation. This might even lead to a specific focus in trace file generation and recording of simulation output data by purposefully introducing a cohort of observers to the model that directly correspond to the type and amount of data required for responding to questions already addressed by the user (Tolujew 1997).

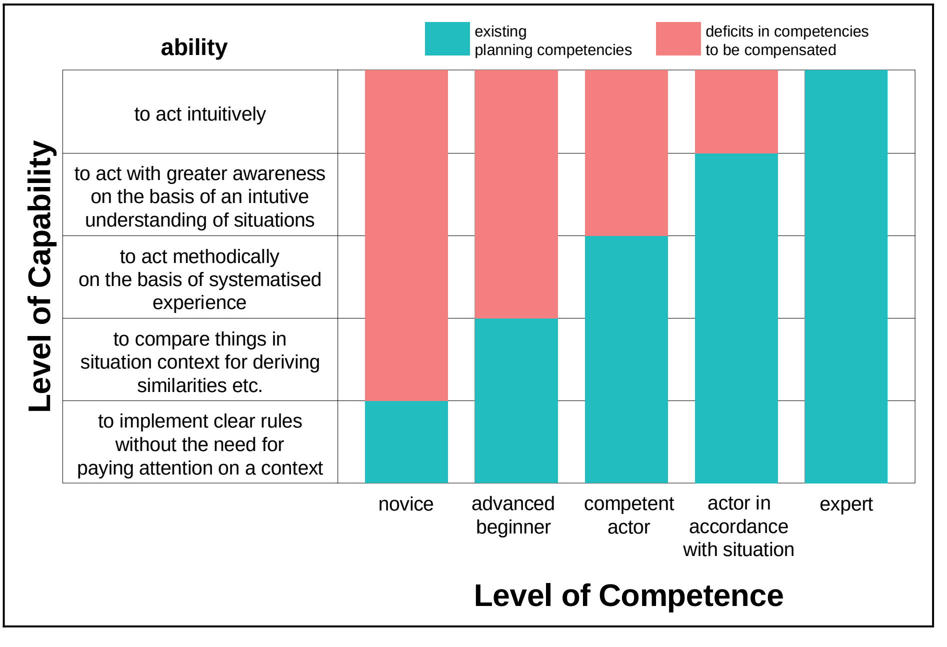
To understand the message of simulation results formal trace file analysis is one important step. The other one is the non-formal, more creative step of directly answering all questions that are of interest to the user (in our case the logistics expert). The precondition is to know (and understand) what the questions of the user are, but also the ability of the user to ask questions relevant to a particular problem. For the latter, the framework for trace file analysis and interpretation provides even further support: Typical questions no matter if they are of generic or specific nature help the user in identifying the problem or the questions to be asked or the aspects to be investigated. As discussed, this can be supported by the approaches for viewpoint description and defining observers or specifying analysis focus. Additionally, a pattern combining typical symptoms (i.e. visible situations or measurable characteristics) with the underlying problems causing those symptoms would be of huge benefit as this might also guide the user in truly understanding what happens in a specific material handling or logistics system.

5. DISTRIBUTING KNOWLEDGE: KNOWLEDGE EXCHANGE AND STAKEHOLDER DEVELOPMENT

In the course of a problem solving process there are bidirectional links between activities for problem solving and knowledge management. On one hand knowledge available with persons, inside organizations and in the form of technology is (re-)used to solve a particular problem. On the other hand knowledge about the problem's final solution and the chosen mode of action for its generation characterizes the increased scientific basis and additional experience of the problem-solving person, team or organization. Usually these links are based upon the persons directly involved in the problem solving process. It's quite common to make use of own experience, but to benefit from knowledge, experience and lessons learned of other parts of the organization that is still not the usual procedure yet. To overcome this and to make knowledge of a successful or even unsuccessful problem solving process available to future planning tasks that is the challenge for knowledge management and its integration into personalized problem solving.

Drawing this picture it becomes pretty clear that logistics problem solving requires a wide variety of knowledge, competences, skills and experiences with the problem-solving person. In particular distinctive problem solving competence is required which can be related to the ability to learn, to be curious and interested in gaining new experience and acquiring additional knowledge. The different levels reached in this process might range from novice to expert, from amateurs to professionals. As shown in Figure 8 (applied to solving logistics planning problems) these different levels not only differ in the degree of independence an individual handles problems with, but also in the need for getting supported to compensate particular deficits. Furthermore, these competence levels are not of static nature. For one and the same person they might vary with respect to the problem to be solved itself or the field it is associated with or the way information and knowledge is accessible or even the methods and tools to be used in a particular situation. Due to the fact that an individual's problem-solving competence depends on his or her knowledge and experience with respect to a particular problem constellation and problem solving procedure, it cannot really be improved within an abstract scenario far from reality. Instead this process is most efficient, effective and successful when associated with a real problem-solving challenge. Here, the development and improvement of abilities and skills can be achieved (i) by the purposeful use of appropriate tools, (ii) by building well-balanced teams, or (iii) by initiating and supporting learning processes. In the end problem-solving capabilities and with this the level of problem-solving competence can only develop over time and through experience, but this process might be speeded up a bit by benefitting from experts' experience instead of gaining all experiences oneself. Therefore, the question for how to efficiently and effectively transfer lessons learned from a more experienced problem-solver to a less experienced person in the field remains one of the key questions in nowadays economic societies.

Figure 8: Problem-solving competences and needs for compensation of deficits



Being aware of this, organizations invest a large amount of money in technology to better leverage information, but often the deeper knowledge and expertise that exists within the organization remains untapped. The sharing of knowledge remains limited in most respects, and at least, strained. APQC (2004) sees major reasons for this in technology that is too complicated and the human nature that poses barriers to knowledge sharing. Cultural aspects can enhance an open knowledge transfer or inhibit a positive attitude towards knowledge sharing. Taking cultural aspects into consideration requires letting the knowledge management approach – and with this the knowledge sharing process in particular – fit the culture, instead of making an organization's culture fitting the knowledge management approach (McDermott and O'Dell 2000).

In a perfect world the benefits of accessing and contributing knowledge would be intrinsic: people who share knowledge are better able to achieve their work objectives, can do their jobs more quickly and thoroughly, and receive recognition from their peers and mentors as key contributors and experts. Nevertheless, knowledge is often not shared. O'Dell and Grayson (1998) identified four common reasons for this:

- *Ignorance*. Those who have knowledge don't realize others may find it useful and at the same time someone who could benefit from the knowledge may not know another person in the company already has it.
- *No absorptive capacity*. Many times, an employee lacks the money, time, and management resources to seek out information they need.
- *Lack of pre-existing relationship*. People often absorb knowledge from other people they know, respect, and like. If two managers don't know each other, they are less likely to incorporate each other's experiences into their own work.
- *Lack of motivation*. People do not see a clear business reason for pursuing the transfer of knowledge.

To meet these challenges, the discipline of knowledge sharing should continuously be reinforced. For this, there are two different approaches: the organization might host visible knowledge-sharing events to reward people directly for contributing to knowledge or the organization might rely on the link between knowledge sharing and everyday work processes by embedding knowledge sharing into "routine" work processes. Here, initiating of a close, interpersonal link between a mentor or coach (the expert) and the novice is a promising way not to rely on enthusiasm only, but to bring in a personal commitment to the process of developing another person's problem-solving competence.

Those expert-novice links might also be part of learning processes to improve an individual's problem-solving competence in a learning-by-doing scenario. The pedagogical framework for this is formulated by the cognitive apprenticeship theory (see Collins et al. 1989): in general an apprentice is a learner who is coached by a master to perform a specific task. Based on this, the theory transfers the traditional apprenticeship model as known from crafts, trade and industry to the cognitive domain. More precise, cognitive apprenticeship aims at externalizing processes that are usually carried out internally. This approach works with methods like modelling, coaching, scaffolding, articulation, reflection and exploration. Against this background coaching is to be understood as helping a person in actively creating and successfully passing individual learning processes through guidance-on-demand. It is a highly focused process that unlocks potential and maximizes performance at both the individual and organizational levels. It helps people gain clarity, remove self-imposed limitations and increase their self-reliance, so they can better leverage their strengths and help others to do the same. Coaching helps individuals to develop critical insight, bringing a new sense of purpose to their actions. It helps them to see where they are, where they want to go to, and how to get there. It stirs them to contribute more. Coaching is a formal system that results in positive, lasting change. In the end, the coach (i.e. the expert) offers support in case of difficulties (i.e. scaffolding), provides hints, feedback and recommendations, and eventually takes over certain steps for solving the given problem. However, the coach only appears when explicitly being called by the person to be coached (i.e. like a help system) and the scaffolding is gradually fading as the learning novice proceeds. So, coaching aims to develop heuristic strategies through establishing a culture of expertise and with this goes far beyond pure learning as typically provided in workplace learning environments.

6. CONCLUSION

Human beings are still and continue to be the key problem solvers, knowledge holders and knowledge users in logistics. User-friendly tools designed in accordance with human needs for computer-based support can help to manage, distribute and provide access to knowledge on one hand and to solve problems on the other hand. They take over routine jobs and deal with those problems the problem-solving person had converted into algorithmic tasks beforehand. In addition to this, intelligent systems can work with sub-problems if they had respective knowledge and suitably distributed processes based on a sophisticated human-computer dialogue. Pre-condition for this is to gain a clear picture about knowledge, abilities and skills of the problem-solving person, to make this knowledge accessible and last but not least to understand a person's problem-solving competence manifested in this.

The paper has discussed and presented chances and barriers for helping knowledge in becoming productive within problem-solving processes. Although many of them have been known for quite some time already, there is still the need for integrating them into a knowledge-friendly environment supporting knowledge acquisition, using, sharing and development of lasting effect. Results from a survey amongst logistics companies clearly gave proof of the increasing interest and understanding within the industrial practice.

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UPRAVLJANJE ZNANJEM NA INDIVIDUALNOJ RAZINI KAO PODRŠKA RJEŠAVANJU LOGISTIČKIH PROBLEMA[3]

Gaby Neumann[4]

Sažetak

Rješavanje problema u logistiki proces je koji uobičajeno zahtjeva intenzivno korištenje znanja i iskustva osobe koja rješava problem. Posljedično, pravilno upravljanje ovim znanjem i iskustvom na individualnoj razini predstavlja priliku i izazov za poboljšanje kapaciteta rješavanja problema dotične osobe. Na temelju ove podloge, kroz rad se nastoji doprinijeti produktivnijem korištenju znanja u procesima rješavanja logističkih problema. Na temelju izjave menadžera logističkog poduzeća koji karakteriziraju znanje kao ključan resurs u svojim procesima koje uglavnom evoluira kroz razne projekte, u radu se identificiraju logistički problemi kao procesi rješavanja problema i navode se tipovi problema koji se javljaju u logistiki. Nadalje, razmotrene su mogućnosti korištenja pristupa upravljanja znanjem u rješavanju logističkih problema s ciljem odgovaranja na sljedeća pitanja: (i) kako ohrabriti i podržati osobe da doprinesu ukupnom znanju uključujući i podizanje svjesnosti o znanju koje već posjeduju, (ii) kako posredovati između različitih tipova znanja koje posjeduju interesne skupine i drugi nositelji i (iii) kako omogućiti i podržati pristup prema znanju i korištenje znanja. Ovo je ilustrirano simuliranim problemima iz logistike gdje su simulacijski modeli prikazani kao nositelji znanja, a inteligentan ljudsko-računarski dijalog je potreban da bi se pristupilo ovom znanju.

Ključne riječi: *upravljanje znanjem, rješavanje problema, logističke simulacije, nositelji znanja, dijeljenje znanja.*

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