KNOWLEDGE CREATION IN OR/MS MODELLING PROCESS*

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Knowledge can be explained as a dynamic human process of justifying personal beliefs. Explicit knowledge is knowledge that is already extracted and consumable in books or other media. Tacit knowledge is not present in explicit form, and can often not be articulated by a person who possesses the knowledge. It can be shared by joint activity. Knowledge creation is a spiralling process of interactions between explicit and tacit knowledge that leads to the new knowledge. The Operations Research/Management Science (OR/MS) modelling process also produces a new knowledge. Its main elements are problem specification, system definition, model selection, testing and verification and model experiments, decision alternative and standard solving approach for similar decision situation. In this contribution the role of OR/MS models in the process of knowledge creation will be explained. The tacit or explicit character of this knowledge and the process of its creation will be explained and discussed.

explicit knowledge; tacit knowledge; knowledge creation; knowledge formalisation; OR/MS models

INTRODUCTION

Knowledge is a basic term in the area of knowledge management and knowledge engineering. Knowledge management seeks to understand the way in which knowledge is used and traded within organisations and treats knowledge as self-referential and recursive. Knowledge management treats knowledge as a form of information, which is impregnated with context based on experience. Quality of knowledge management is the basis of quality of the decision-making process and a competitive advantage of organisations (Bernbom, 2001; Dretske, 1981; O'Leary, 1998; Probst et al., 1999; Tiwan, 2002).

There are many definitions of knowledge. In order for it to be knowledge, at least three criteria must be fulfilled. A thought must be justified, correct, and trusted. Thus knowledge can be defined as a dynamic human process of justifying personal beliefs as part of an aspiration for truth.

Another definition postulates that knowledge is information combined with experience, context, interpretation, and reflection. It is a high-value form of information that is ready to apply to decisions and actions (Davenport, 1996; Davenport, Prusak, 1998).

Knowledge can be divided in both tacit knowledge, which involves senses, skills and intuition, and explicit knowledge, which is formulated and/or captured. Explicit or codified knowledge refers to knowledge that is transmittable in formal, systematic language. Explicit knowledge is knowledge that is already extracted and consumable in books or other media. On the other hand, tacit knowledge has a personal quality, which makes it hard to formalize and communicate (Nonaka, Takeuchi, 1995). Tacit knowledge is not present in explicit form, and often can not be articulated by a person who possesses the knowledge.

Knowledge management today maintains the exploitation, improving and creating of an intellectual capital, knowledge. Knowledge creation is a spiralling process of interactions between explicit and tacit knowledge that leads to the new knowledge (Nonaka, Takeuchi, 1995). The Nonaka model sets four phases in this process – **S**ocialisation, **E**xternalisation, **C**ombination and **I**nternalisation. Therefore this model is called the SECI model. Realisation of this process and utilisation of knowledge requires a possibility of knowledge formalisation.

Knowledge and knowledge creation represent the key factors in decision-making. The complexity of today's business problems has made the decision-making process increasingly difficult. It is no longer possible for one individual to be aware of the details of every characteristic of a company or to make all decisions regarding its operation. The complexity of the global world needs a system approach to decision-making.

The systems approach is based on the perspective of the systems sciences, which seeks to understand interconnectedness, complexity and wholeness of components of systems in specific relationship to each other. Systems thinking embraces the values of reductionism by understanding the parts, and the constructivism which seeks to understand the whole, and more so, the understanding of the complex relationships that enable the parts to become the whole (Senge, 1990). A deci-

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sion-making process is characterised (Habr, Vepřek, 1986; Gigch, 1991; Simon, 1960) as a scientific approach based on system approach, Operations Research/Management Science (OR/MS) models and modelling (Gigch, 1991; Bonini et al., 1997; Habr, Vepřek, 1986; Turban, Meredith, 1991; Stevenson, 1989). The basic steps of system approach are problem formulation, system definition, model building, model testing, verification, model experiments and lastly interpretation and implementation of model results.

The role of system approach modelling and OR/MS models in knowledge creation process and type of knowledge included in this process will be described in this paper. This problems have been discussed in Brožová, Havlíček (2005), Beránková, Houška (2005) and Dömeová, Houška (2005). The aim consists of analysis of different characters of knowledge in system approach and OR/MS modelling process. Therefore we start with a recapitulation of the SECI model of knowledge creation process (Nonaka, Takeuchi, 1995) as well as a recapitulation of system approach and OR/MS modelling process (Habr, Vepřek, 1986; Gigch, 1991; Simon, 1960). Ultimately the analysis of parallel elements in both processes will be shown and graphically described.

MATERIAL AND METHODS

SECI model of knowledge creation process

Nonaka and Takeuchi (1995) proposed a well-known definition of the knowledge creation process as a spiralling process of interactions between explicit and tacit knowledge that leads to the creation of new knowledge. The combination of these two categories makes it possible to conceptualise the SECI model with four conversion phases:

- Socialisation,
- Externalisation,
- Combination and
- Internalisation.

Nonaka and Konno (1998) later included the concept of Ba in this SECI model. The concept of Ba originally proposed by Japanese philosophers can be defined as common context in which knowledge is shared and created through interaction. Ba provides a platform for advancing individual and/or collective knowledge. There are four types of Ba that correspond to the four stages of the SECI model. Each category describes a Ba especially suited to each of the four knowledge conversion modes.

- **Socialisation** enables the sharing of tacit knowledge through interaction between individuals. The tacit knowledge is exchanged through joint activities and experience rather than through language and written or verbal instructions. The space, where individuals can share feelings, emotions, experiences and perceptual models, can be expressed as **the Originating Ba**.
- **Externalisation** requires the explicit expression of tacit knowledge into a form that can be understood by others. During this stage tacit knowledge is transformed into explicit knowledge. Two key methods are dialogue and metaphor creation. **The Dialoguing Ba** is a space where tacit knowledge is transferred and documented to explicit form.
- **Combination** generates the new knowledge as a complex set of explicit knowledge. Communication, diffusion and systemization processes are crucial for creating this new knowledge. **The Systematizing Ba** is a virtual space, where information technology facilitates the recombination of existing explicit knowledge to form new explicit knowledge.
- **Internalisation** of newly created knowledge is the conversion of explicit knowledge into the organization's tacit knowledge. The individual has to identify relevant knowledge and learn it by doing, training and exercises. **The Exercising Ba** is a space where explicit knowledge is converted into tacit knowledge (Fig. 1).

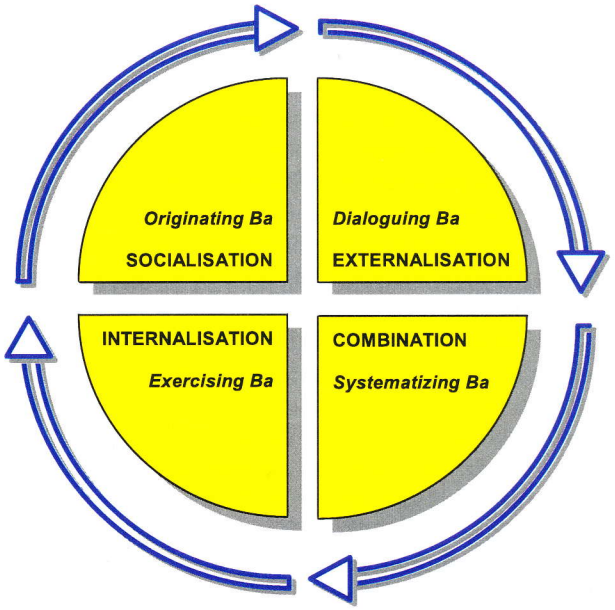

Fig. 1. The SECI spiral of knowledge creating process

OR/MS modelling process

System approach and OR/MS modelling process represents the scientific solving of complex organisational decision problems. Improvement of an existing system and good design of new system are the goals of this approach.

Operations Research/Management Science (OR/MS) modelling process (Stevenson, 1989; Turban, Meredith, 1991; Bonini et al., 1997) is a crucial part of system approach to problem solving, regardless

of the nature of the system, product, or service. The basic steps of this process are:

- Problem formulation
- System definition
- Model building
- Model testing and verification
- Model experiments
- Results interpretation and implementation.

- **Problem formulation** is the most important part of a decision-making process. The formulation of a problem is often more essential than its solution. In fact, understanding a problem usually indicates the ways and means of solving it.
- **System definition** means the first step of problem formalisation. It is a representation of modeller's thoughts about reality and it is typically expressed by words and graphical symbols using system theory terms as system, elements, relations, transformation, boundaries and so on. The definition of boundaries, subsystems, components and their relations is an arbitrary process.
- **Model building** is the base of OR/MS modelling approach. A model is a representation of reality from the modeller's perspective. Therefore, it is an objectification of reality, which in turn means a subjective view of reality. Such a model can often be mathematical. Mathematical models employ mathematical tools, symbols and notations, including numbers.
- **Model testing and verification** measure the quality of a model. The understanding created by a model and the effectiveness of the results of the application of any OR/MS models is a function of the degree to which the model represents the studied system. To define those conditions, which will lead to a valid and rational solution of a systems problem, the analyst must first identify a criterion by which the performance of the system may be measured. This criterion is often referred to as the measure of the system performance or the measure of effectiveness. If the model was built well, the model will adequately show the behaviour and problems of investigated reality.
- **Model experiments** follow the steps of a model building and model verification. Solution of model with different data quantification provides different alternatives of problem solving and can improve the understanding of problems. Different algorithms (a series of steps that will accomplish a certain task) are used to realize these experiments. The study, understanding, and invention of such algorithms are also important parts of OR/MS modelling.
- **Results interpretation and implementation:** If the mathematical model is a valid representation of the performance of the system, by the application of the appropriate analytical techniques the solution obtained from the model experiments should also be the solution to the system problem. The analytical results obtained from an analytic model must always be tempered with experienced judgment, since there usually exist factors that cannot be included in the model. Communicative and political skills of a decision-maker are also needed in implementing the results of an OR/MS model in a real-life situation (Fig. 2).

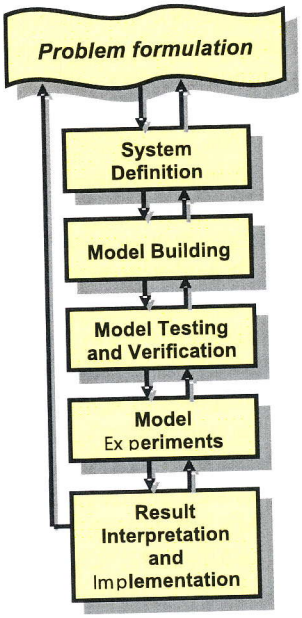

Fig. 2. OR/MS Modelling Process

RESULTS

Character of knowledge in OR/MS modelling process

OR/MS modelling process is a knowledge-based approach in frame of which knowledge, information and data are working up to create new knowledge and information. In each phase of the process different sorts of knowledge are used and created. The following text shows this process from the point of view of embodying of tacit and explicit knowledge.

Problem formulation and system definition – tacit knowledge socialisation

OR/MS modelling process in the frame of General System Theory is a scientific, philosophical and methodological approach often likened to art. Problem analysis and problem specification is the first step in this process and problem dividing into several well-structured or semi-structured problems and proper system definition is the second step. These steps need not only technical skills (explicit knowledge of theoretical background of solved problem, of system approach and knowledge of general definition of system) but also and especially good experience and craftsmanship (tacit knowledge necessary for right problem analysis and proper definition of system).

Persons educated in General System Theory and with a theoretical background of solved problems know the general definition of system, but without good practice they will not be able to define the proper system of the real object. An experienced person has not only this explicit knowledge but also tacit knowledge as practice, intuition and sense to set the important points of view, important elements of reality, their relations, behaviour and criterion.

To be the best modeller one needs to start by apprentice work and practice, because sharing of this tacit knowledge involves joint activity and direct interaction with experienced people.

Model building – externalisation of tacit knowledge

The model-building phase follows the system definition and represents knowledge externalisation, which involves translating the tacit knowledge into explicit. The tacit knowledge of the system definition and model selection and explicit knowledge of OR/MS models, their properties and solving algorithms, is translated into a readily understandable form – the best model selected and suitable for the identified system.

For instance, good knowledge of a linear optimisation model and its properties is not enough for its right practical application. First it must be proven that this application is adequate. Next, it is necessary to find a way, how all system elements and properties (tacit knowledge from previous phase) can be assigned to elements of a selected linear optimisation model, which elements will be represented by variables, which by linear inequations, which by linear criterion function and so on.

The model and the way of its application as well as results interpretation may be used for solving many similar problems and this will be a typical pattern of decision-making. The selected model and its application to problem solving represent explicit knowledge that is created as the best practice and can be understood beyond its linguistic, organisational and cultural context.

Model testing and verification, models experiments – explicit knowledge combination

A process of model testing and verification consists of comparison of model and reality. This process has a standard form including ex ante and ex post testing and verification of model results. At this stage knowledge about the real object and its behaviour and properties is combined with data and information obtained by model calculation with different input data in order to investigate model quality. Once positive results of this testing have been assessed, the model can be used for further model experiments. Model calculation is again provided with different quantification with the aim to receive exact data and information for future decision-making.

For good decisions it is helpful to understand the nature of the problem by asking "who?", "what?", "why?", "when?", "where?" and "how?" Since the strategic solution to any problem involves making certain assumptions, it is necessary to determine changes of the solution when the assumptions change. This can be assessed by performing the so-called "What-If analysis" as well as by creating proper scenarios. What-if analysis through this model is a process, which enables investigation of the effect of different decisions retrospectively. This implies a presupposition; as if the decision had already been made under a different course of actions and the output (which is the result of our action) must be considered first.

To provide effective and reasonable model experiments requires not only having theoretical knowledge about this process but also having practical experience with it. This means that the results at this stage also depend on tacit knowledge.

Explicit knowledge about future development of solved problems in case of different initial situations is obtained at the end of this stage.

Model results interpretation and implementation – internalisation of explicit knowledge

In this last phase, the new explicit knowledge is embodied in action and practice. The combination of explicit knowledge and information with diverse contexts obtained in a previous phase implies the analysis of obtained results, their interpretation and implementation of this information.

Without good practice, a decision-maker will not be able to analyse important facts and their consequences and choose the best decision alternative. This activity consists of many similar problems as the practical definition of system in the phase of socialisation. As a result of this phase the specific application of OR/MS modelling and the OR/MS model particularly constructed for solution of formulated problem is worked out. It is an important yet intuitive and experiencing activity, which creates knowledge in tacit form. This knowledge supports the decision-making process. People can repeat this process as a whole with the aim to receive decision alternatives in similar decision problems but they are not able to modify this approach in different situations.

The process of exploitation of models, system of models and results of models experiments is included into organisational knowledge base as a new specific modelling process and can be used by other members of staff in similar decision situations as a standard. Because these specific models can be shared mainly by field experience, by cooperative action of people, the standards become a set of tacit knowledge.

As we have shown, the OR/MS modelling process is a specific interpretation of the SECI model of knowledge creation process. Every phase results in new knowledge important for decision-making, which is managed by

Table 1. Overview of knowledge in OR/MS modelling process

SECI process	OR/MS modelling process		
	Phases	Explicit knowledge	Tacit knowledge
Socialisation and Originating Ba	Problem formulation System definition	Theoretical background of solved problem Theory of system approach General definition of system	Practical analysis of problem **System identification**
Externalisation and Dialoguing Ba	Model building	Theory of OR/MS models **Selected model**	Practical selection of the best model suitable for identified system
Combination and Systematising Ba	Model testing and verification Model experiments	Theory of model testing and verification Theory of model experiments **Model results**	Practical planning of model experiments with different quantification
Internalisation and Exercising Ba	Results interpretation and implementation	Theoretical background of solved problem Theory of management Theory of modelling	**Specific modelling approach for decision process**

The output of each phase is written in bold and underlined letters

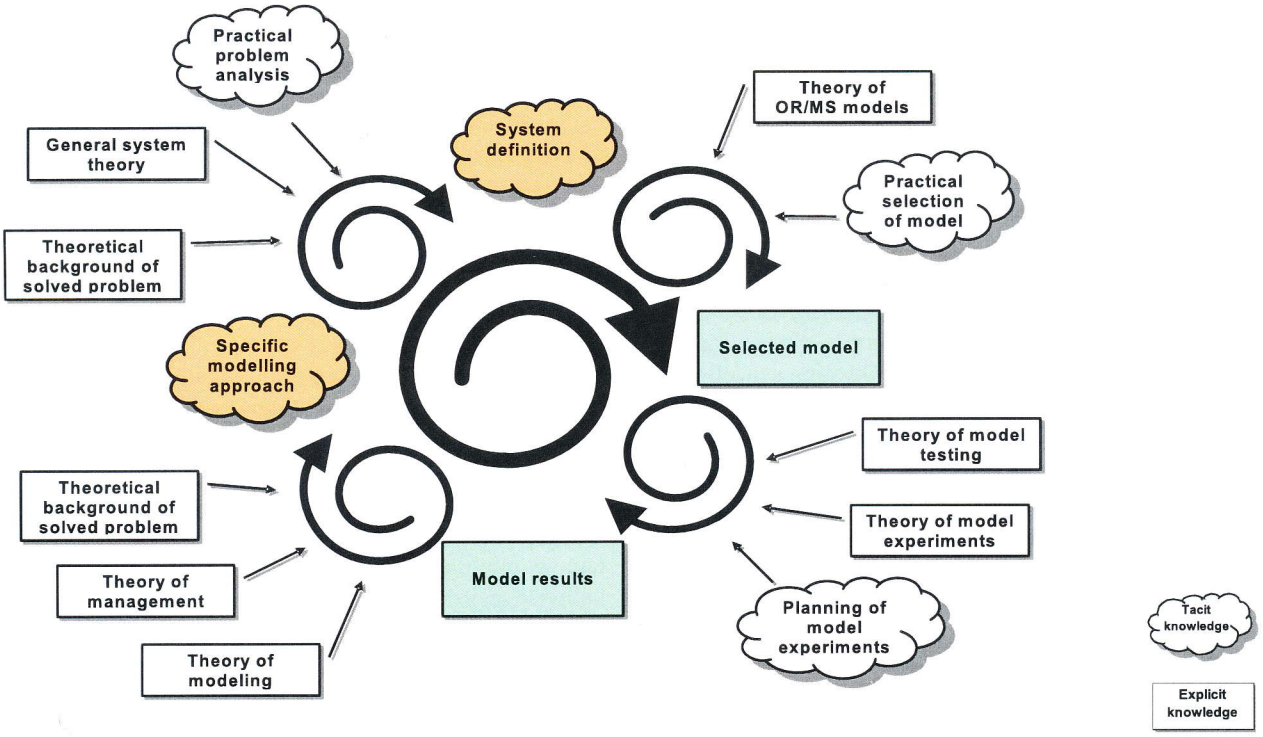

Fig. 3. Hierarchical structure of SECI spiral in OR/MS modelling

an organisation knowledge system. Moreover, each phase of SECI representation in OR/MS modelling process can also be explained as a special representation of SECI model because the explicit and tacit knowledge involved in this phase creates new knowledge. Thus partial internal SECI spirals of the knowledge creation process can be identified inside the main spiral and the whole knowledge creation process has a hierarchical structure.

Table 1 shows core tacit and explicit knowledge in discussed process. Fig. 3 visualises the interactions between tacit and explicit knowledge in the OR/MS modelling process and the consequent knowledge, which is important for the following stage.

DISCUSSION

We have shown the parallels between the SECI model and the system approach and OR/MS modelling process. The system approach and the OR/MS modelling process

include both types of knowledge – tacit and explicit. The elements of knowledge mentioned below are important in the whole process of knowledge creation.

A pool of explicit knowledge includes principally:
- General definition of system
- General model form
- Typical way of model application and results explanation
- Explicit model simplification
- Solving algorithm
- Well-structured problem solving

Important elements of tacit knowledge are:
- System identification of solved problem
- Special ways of model application
- Problem description through model
- Model building – quality and quantification of model
- Planning model experiments
- Results explanation and implementation
- Semi-structured and ill-structured problems solving

We have also shown, that the internal SECI spiral creating new knowledge can be specified for every phase of the knowledge creating process based upon the OR/MS modelling approach.

We may conclude that the whole OR/MS modelling approach is a concrete realization of the SECI model of knowledge creation process. At each individual stage partial a SECI spiral of creation of single partial knowledge can also be identified, because its creation is based on mutual interaction of explicit and tacit knowledge. Table 1 shows parallels between each stage of the knowledge creation process, system approach and exploitation OR/MS models. Figure 3 shows hierarchical structure of the knowledge creation spirals in OR/MS modelling process serving for solving of decision-making problems of organizations.

Future examination has to be developed for the third stage in system design – for metamodelling. "Meta" view to SECI spiral is a methodically and theoretically important form of its analysis.

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BROŽOVÁ, H. – ŠUBRT, T. (Česká zemědělská univerzita, Fakulta provozně ekonomická, katedra operační a systémové analýzy, Praha, Česká republika):

Tvorba znalostí v procesu aplikace OR/MS modelů.

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Znalosti a znalostní management jsou fenoménem současné společnosti a představují nehmotný kapitál organizací. Kvalitní znalostní management, tj. způsoby uchovávání, rozšiřování a sdílení znalostí, je předpokladem kvality rozhodovacího procesu ve firmách a tím konkurenceschopnosti firem (Bernbom, 2001; Dretske, 1981; O'Leary, 1998; Probst et al., 1999; Tiwan, 2002).

Cílem příspěvku je analýza systémového přístupu v rozhodovacím procesu, modelování (Habr, Vepřek, 1986; Gigch, 1991; Simon, 1960) a využívání modelů OR/MS (Operation Research and Management Science) z hlediska přínosu pro rozvoj znalostní báze organizací a především tvorby nových znalostí (Brožová, Havlíček, 2005; Beránková, Houška, 2005; Dömeová, Houška, 2005). Znalosti v tomto procesu jsou specifikovány a charakterizovány a je popsán způsob jejich sdílení a uchovávání v organizaci. Proces tvorby nových znalostí v OR/MS modelech a modelování je konfrontován s modelem SECI (**S**ocializace, **E**xternalizace, **C**ombinace a **I**nternalizace). Je nalezena a vysvětlena paralela mezi těmito dvěma procesy.

Transformace znalostí je cyklický proces, který obsahuje v různých fázích individuální i skupinovou činnost lidí. Nejrozšířenější popis tohoto procesu podávají Nonaka, Takeuchi (1995) a Nonaka, Konno (1998) pomocí modelu SECI.

Ve fázi **socializace** jsou předávány tacitní znalosti v rámci společných činností a praktického učení. Komunikační nástroje, především jazyk, zde hrají méně významnou úlohu, protože tacitní znalosti jsou prakticky nesdělitelné a klíčovým faktorem je zde zkušenost. Komunikace může celý proces urychlit pouze přesným vnějším popisem prováděných kroků.

Externalizace je fází, ve které dochází v rámci skupiny jednotlivců k takové úrovni poznání a pochopení, že znalost původně tacitního charakteru se stává znalostí explicitní. V této fázi je velmi důležitá možnost jejího zachycení ve formě psaného či mluveného textu.

Ve fázi **kombinace** znalostí je tento proces dokončen a sdělování a rozšiřování znalostí se děje na základě jejich kodifikace, tedy především jazykovými prostředky, ale též různými grafickými, matematickými a dalšími nástroji.

Souhrn či systém znalostí se stává ve fázi **internalizace** tacitní znalostí organizace. Jednotlivci pak musí být schopni potřebné znalosti najít a získat. Tím je celý proces cyklicky uzavřen.

Rozhodovací proces je podle Simona (1960) možné rozdělit do tří rozsáhlých fází: inteligenční, projektování a volby.

Inteligenční fáze (informační) obsahuje tyto kroky: identifikace problému, analýza a diagnostika problému, identifikace a vymezení cílů a účelu rozhodovacího procesu a vytipování, výběr, shromažďování, ověřování a doplňování dat.

Fáze **projektování** je fází tvorby alternativ řešení problému. Obsahuje různé postupy zpracování dat a kvantifikace cílů a účelu rozhodování, od spontánních (rozvahy, panelové diskuse atd.) až k vysoce formalizovaným postupům (matematické modelování, tvorba ikonických modelů atd.).

Fáze **volby** je fází, v níž je pak proveden výběr konečného rozhodnutí. Tato fáze předpokládá simulaci výsledků rozhodování, vysvětlení a výběr variant a alternativ a zdůvodnění tohoto výběru. Vybrané rozhodnutí pak musí být realizováno. Postup této realizace však podle Simona představuje nový rozhodovací proces, takže se fáze inteligenční, projektování a volby opakují.

Systémový přístup a modelování podle autorů Habr, Vepřek (1986) a Gigch (1991) je specifikován podrobněji a obsahuje i proces implementace vybraného řešení. Postup začíná **analýzou a popisem řešeného problému**. V této fázi dochází ke kombinaci explicitních teoretických znalostí (teoretický základ řešeného problému, definice systému) s praktickou zkušeností s tímto krokem. Výsledkem je znalost v tacitní formě, schopnost popsat problém a **identifikovat vhodný systém** včetně konkrétního popisu problému a systému. Tato fáze odpovídá fázi socializace znalostí, je to proces často přirovnávaný spíše k umění než k vědecké činnosti.

Konstrukce modelu (Bonini et al., 1997; Habr, Vepřek, 1986; Turban, Meredith, 1991; Stevenson, 1989) opět není možná bez explicitních teoretických znalostí (obecný model a jeho vlastnosti), ale pro konkrétní problém vychází z identifikace systému. Výstupem tohoto kroku je vybraný model přizpůsobený řešenému problému. Tento model je popsán svojí modelovou konstrukcí a jsou známy předpoklady a možnosti jeho použití. Jde tedy o znalost v explicitní podobě. Tato fáze tedy obsahuje proces externalizace znalostí, na základě tacitní znalosti je získána znalost explicitního typu – model pro danou rozhodovací situaci.

Testování a verifikace modelu (Habr, Vepřek, 1986; Gigch, 1991) spočívá v porovnání chování modelu a problémové situace. V této fázi je ověřována shoda modelu a reálné situace, jak dobře je problém modelem popsán. Zjišťování kvality modelu je postup s pevně stanovenými kroky, při nichž se ověřuje chování modelu na základě

minulého vývoje problémové situace (ex post), na základě předpokládaného budoucího vývoje situace (ex ante) a na základě analýzy reakcí modelu na extrémní vstupní data.

Vybraný a ověřený model je pak použit pro **modelové experimenty** (Habr, Vepřek, 1986; Gigch, 1991), výpočty s různými vstupními daty, při nichž jsou získávána data a informace nezbytné pro volbu správného rozhodnutí.

Postup testování a verifikace modelu a modelových experimentů obsahuje kombinaci různých znalostí, na jejichž základě jsou získána data a informace a další explicitní znalosti o chování řešeného problému.

Poslední fází modelové tvorby je **analýza, interpretace a implementace řešení** (Habr, Vepřek, 1986; Gigch, 1991), tedy volba a realizace alternativy rozhodnutí. Na základě explicitnich znalostí získaných v předchozí etapě je navrženo modelové řešení problému. Toto řešení a postup jeho získání se stává novou znalostí, avšak znalostí tacitního typu. Jedná se vlastně o typizované či standardní postupy řešení, které je možno použít i v dalších podobných situacích. Pro sdílení této znalosti je však určující její tacitní charakter. Tato znalost je konečným výsledkem celého procesu tvorby znalosti, není ji možno popsat algoritmem jejího získání a slouží jako základ pro další rozvoj znalostní báze organizace.

Gigch (1991) charakterizuje systémový přístup a celý proces modelování jako část procesu, který nazývá **System Design**. Tento proces člení do tří větví – realita, modelování a metamodelování. První dvě větve **realita** a modelování je možno charakterizovat jako **System Improvement.** Ty byly v tomto článku z hlediska tvorby znalostí analyzovány. Třetí větev **metamodelování** je pak navazující větví, ve které jsou řešeny problémy spojené s neúspěchem modelového přístupu. I výsledkem této větve jsou znalosti, které významným způsobem rozšiřují znalostní základnu organizace. Jejich analýzou se však tento článek nezabývá.

Z analýzy znalostí, jejich charakteru a role v systémovém přístupu, modelování a modelech OR/MS vyplývá, že tyto postupy obsahují oba typy znalostí – tacitní i explicitní – současně. Důležitost jednotlivých znalostních typů je však v jejich různých fázích různá.

Do skupiny explicitních znalostí patří především:
- Obecný teoretický základ řešeného problému,
- Obecná definice systému,
- Obecná forma modelů,
- Obecný způsob aplikace modelů a interpretace modelových výsledků,
- Explicitní proces zjednodušování v OR/MS modelech,
- Algoritmy řešení a modelových výpočtů,
- Postupy řešení dobře strukturovaných problémů.

Tacitními znalostmi pak jsou
- Speciální znalosti v problémové oblasti,
- Identifikace systému pro řešený problém,
- Speciální konkrétní způsob aplikace modelů,
- Popis problému pomocí modelu,
- Konstrukce vhodného konkrétního modelu a jeho kvantifikace,
- Plánování modelových experimentů,
- Interpretace a implementace výsledků modelových výpočtů,
- Řešení částečně a špatně strukturovaných systémů.

Uvedené typy tacitních a explicitních znalostí se vzájemně prolínají a ovlivňují, přetvářejí se v rámci této interakce a v rámci organizace jsou sdíleny.

Je tedy možno říct, že celý proces OR/MS modelování je konkrétní realizací SECI modelu popisujícího tvorbu znalostí. Navíc v každé jednotlivé fázi je možno identifikovat parciální SECI spirálu tvorby jednotlivých dílčích znalostí, neboť i jejich tvorba je podmíněna vzájemnou interakcí explicitních a tacitních znalostí. Tab. 1 uvádí vzájemné paralely mezi jednotlivými fázemi procesu tvorby znalostí, systémového přístupu a využívání OR/MS modelů. Obr. 3 ukazuje hierarchickou strukturu (hlavní a dílčí spirály) procesu tvorby znalostí při OR/MS modelování využívaném pro řešení rozhodovacích problémů organizací.

explicitní znalost; tacitní znalost; tvorba znalosti; formalizace znalosti; OR/MS modely

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