MODELLING RISK DEPENDENCIES WITHIN COMPLEX SITUATION MANAGEMENT CONCEPT

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The present paper emphasizes complex situation management in case of the process technologies. The main objective of the research was to provide a framework for process technologies in order to investigate a wide variety of stressor or risk sources, to provide a tool that offers the input needed for Decision-Support Systems to visualize the dependencies and the interdependencies within process engineering. The methodology is based on expert elicitation namely semi-structured interviews in order to design the key elements – dependencies that might not be obvious at a first glance when designing the complex process architecture. The main result of the paper is to propose a sequence of steps that may be followed in order to obtain a holistic risk assessment. The originality of the paper arises from the fact that the holistic risk assessment includes not only all-hazard approach yet also elements of capability management and resilience governance. In order to obtain a better visualization of the model, the paper embedded the key concepts and key mechanisms of object-oriented modelling in order to build a complex situation model that includes the risk dependency evaluation.

Keywords: complex situation model; object-oriented modelling; process technologies, risk assessment

1. Introduction

If a system gets in a special situation or something unexpected has happen the Complex Situation Management provides some useful instruments. A stressor is the only source that could create a complex situation. A stressor can be a single unique event, a repeatable issue or a specific incident. A stressor can be unknown, unpredictable, uncertain, fuzzy or hazy. Nevertheless, a stressor can be structured and documented in a comprehensive way - Account-Model - to learn from, if necessary.

A Complex Situation is in fact a normal situation at a given moment or in a given circumstance, a copy of normal situation in a specific context. The difference is that perhaps not all available information about a system context is used or specific information is not available at this time. The Multi-Dimensional

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Description about a specific system context can be at any time systematically reduced or enlarged. Therefore, the system context is always a valid digitalized virtual image about a real or imaginary system available as Account Model.

Making complexity transparent and manageable is the key factor to support innovation, to guarantee that innovation can be implemented into practice, to apply the highest professionalism and to recognize and apply possibilities for improvement.

Market comes with other requirements and generally a product grows till it reaches its market saturation level. Thus, there is a need for a methodology assisted by an analytical platform.

The present paper comes as a result of a literature survey within process technologies assessment. Some of the investigated papers [1-3] present risk assessments within process technologies' field, yet take into consideration only operational/technological risks. The main objective of the research was to provide a framework for process technologies in order to investigate a wide variety of stressor or risk sources, to provide a tool that offers the input needed for Decision-Support Systems to visualize the dependencies and the interdependencies within process engineering.

To manage a complex situation properly additional steps techniques are sometimes helpful and essential. There is always a gap in dependency management because elements of a system are always better documented and managed than relations and dependencies. With a Risk Dependency Map, the entire collaboration between all elements in a Complex Situation stored as an Account-Model can be additionally documented, visualized, measured and analyzed. Cause Effect-, Impact- and Loop analyses can be supported as well as multidimensional calculations and measuring. With an optional Risk Dependency Evaluation, the risk shift and risk dependency shift can be additionally documented, analyzed and visualized over time. With the Predetermined Breaking Point Analyses the entire Complex Situation available as an Account-Model can be additionally analyzed. The special focus of the Predetermined Breaking Point Analyses is to prepare a system, not to collapse in special situation or to reduce the impact. With this kind of analyses and preparation a System Context as well as Complex Situation resilience can be improved. Predetermined Breaking Points can be implemented across the entire model.

2. Research methodology

The methodology is based on expert elicitation namely semi-structured interviews in order to design the key elements – dependencies that might interfere during complex situations related to process engineering. In order to obtain a better visualization of the model, there were embedded the key concepts and key

mechanisms of object-oriented modelling in order to build a complex situation model that includes the risk dependency evaluation.

a. Object-oriented modelling

Object-Oriented Modelling (OOM) may be seen as a collection of cooperating objects, as opposed to a traditional view in which a program may be seen as a list of instructions to the computer. In Object-Oriented Programming (OOP), each object is capable of receiving messages, processing data, and sending messages to other objects. Each object can be viewed as an independent little machine with a distinct role or responsibility.

It also uses several concepts/techniques from previously established paradigms, including inheritance, modularity, polymorphism and encapsulation. These concepts give support to the development of efficient class structures. The aim is to approximate the behavior of the real-world elements within the software environment [4].

OOP works with some key concepts (class, object, and message passing).

A class defines the abstract characteristics of a thing, including the thing's characteristics (its attributes or properties) and the things it can do (its behaviors or methods). It is a template for defining similar objects, providing the basis for abstracting the common characteristics of real-world objects.

A particular instance of a class and executable software representations of real-world concepts are objects. Most broadly defined, an object is a software package that includes all the necessary data and procedures to represent a real-world object for a specific set of purposes. Objects are not only physical, they can also be conceptual.

Objects interact with each other by sending requests for services known as messages. A message is a request to a particular object to invoke a specified procedure, which is typically called a method. It is universal communication medium through which objects interact with one another.

According to Taylor [5], in OOP the objects support some mechanisms: encapsulation, messages support polymorphism, and classes support inheritance.

All those concepts were taken into consideration when gathering data for the model.

b. TopEase as modelling environment

All theoretical aspects explained above can be found in different software products. The authors chose TopEase as environment for modelling the process technologies.

Software TopEase is a business application that provides solutions to the problems from variety of sectors like economy, engineering, health and law enforcement.

Artifacts can be specified in attributes and behaviors and references. When the rules are specified and accepted, a multi model can be developed to describe a complex system like an enterprise. TopEase provides many predefined artifacts and applied rules.

Complex economics, permanent change and adaptation to new markets, trends and opportunities demand for quick but sound decisions. These decisions must be based on timely and accurate information from various sources. It is the aim of TopEase to provide to the manager this necessary critical information with a comprehensive and easy to use tool.

TopEase approach, called also the 1-3-5-7 Axiom, provides balanced solution to complex relationships within a system as follows [6]:

- A methodology helps to get a common understanding based on an agreed terminology. This provides a targeted, result driven and stakeholder oriented approach in order to generate added value.
- Three layers help to get a simple target audience related business structure. These layers are Definition Layer, Support Layer and Implementation Layer.
- With five core models, a system can be modeled, documented and elaborated. If all artifacts are modeled properly, the system can be validated with value chains and questions. These models are Business Model, Resource Model, Information Model, Delivery Model and Change Model.
- If the essential seven questions are asked on all nodes, a balanced Multi Dimensional System Description will be available. 3 layers and 5 models do not stand for themselves. They have dependencies and interrelations. These connections must be analyzed, validated and interpreted. It is good practice to describe the nodes by asking 7 relevant questions to the characteristics of these arcs. In general, these questions are about: Cost, Benefit, Risk, Quality, Feasibility (procedure (how)), Manageability (people (who)) and Impact.

3. Results

If a system, system of systems or a system context gets stressed, a complex situation arises. A complex situation requires increased attention. The so-called stressors are therefore the reason for a complex situation. The challenges of complex situations are, often unpredictable, unexpected and unknown. After stressors and other influence factors are documented the required multi-dimensional system description can be reused to manage those exceptional situations. In many cases the same instruments, indicators and visualization can be used to manage complex situation. In a complex situation because they are unexpected often information is not available, not in an acceptable level of details

or quality. To bridge these caps placeholders can be incorporated in a model to close gaps or to simulate behaviors (see Fig.1).

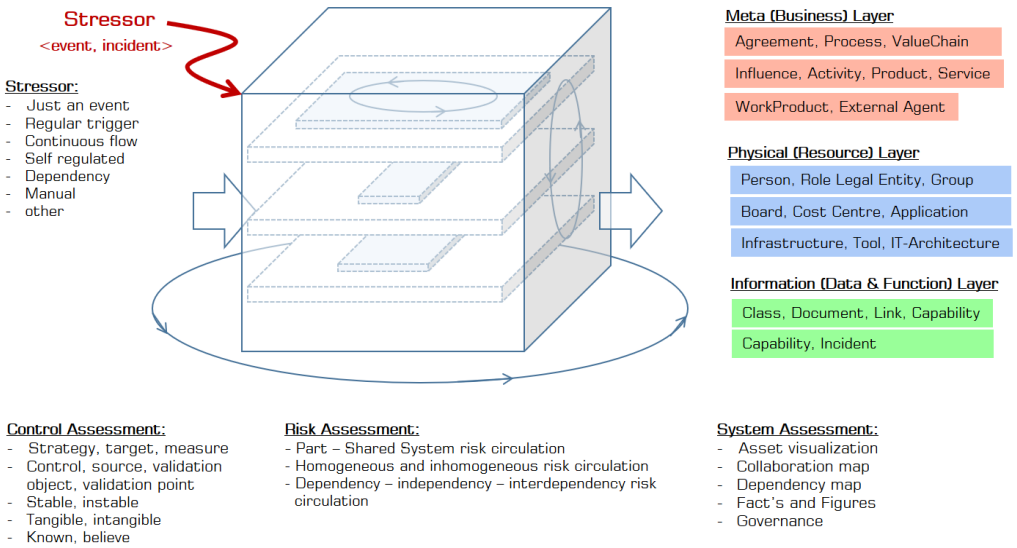

Fig.1 Complex Situation description.

A complex situation is in fact a normal situation at a given moment or in a given circumstance, a copy of a normal situation in a specific context. The difference is just that perhaps not all available information about a System of Systems are used or specific information are not available at this time.

The Multi-Dimensional Description about a specific System of Systems Context can be at any time systematically reduced or enlarged. Therefore, it is always a valid digitalized virtual image about a real or imaginary system available as model. To manage a complex situation, additional steps techniques are helpful and essential. To manage a complex situation properly perhaps additional information are required. This information can be incorporated on the Meta-, Physical- as well as on the Information Layer. Additional System- Risk- and System Assessments are required to find the most effective an efficient way to manage a complex situation. There is a lot of additional analyses functionality available and helpful. The most important and critical factors in managing a complex situation are time, overview and ownership, meaning a Multi Dimensions System.

Description offers always a value for comprehensive analyses, simulation and action planning (see Fig. 2).

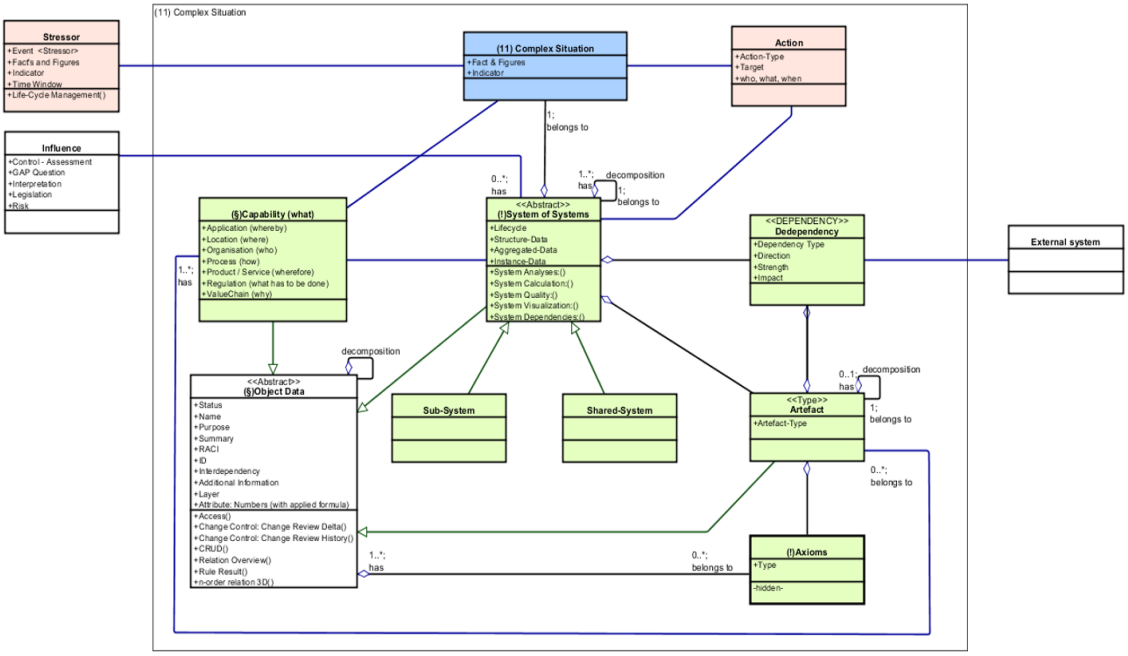

Fig.2 Complex Situation Model

An additional very important instrument with added value is a dependency map. With a dependency map the collaboration can be visualized and an analysis can be applied like cause-effect analyses, loop analyses, impact analyses, etc. If just the risks and their dependencies and interdependencies are visualized a lot of value can be generated (see Fig. 3). Today nearly everything is depending on each other and therefore maps like risk dependency maps are important. With this map the problem risk or solution risk can be identified and system capabilities can be easily documented. This map can also be used in a normal situation to support a risk evaluation.

There is always a gap in dependency management because elements of a system are always better documented and managed than relations and dependencies [7].

With a risk dependency map, the entire collaboration between all elements in a Multi-Dimensional System Description can be documented, visualized, measured and analyzed. Cause Effect-, Impact- and Loop analyses can be supported as well as multi-dimensional calculations and measuring. To get a valid high quality Risk Dependency Map a solid consistent System of System Description is essential and required.

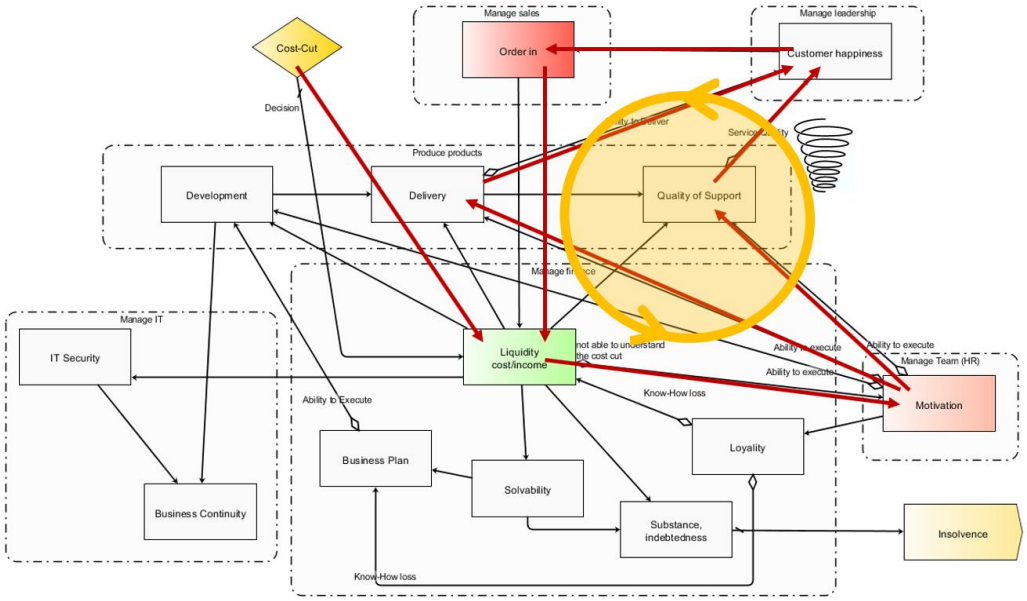

Fig. 3 Risk Dependency Map

If a complex situation has too many dependencies, the dependencies are difficult to understand or to separate. For each risk step an individual risk map can be generated. If all scenarios are documented, a risk cube arises with which covers impact, likelihood and dependencies for the most relevant states. This is the fastest way to get a brief overview about risk assessment of a risk dependency map (see Fig. 4).

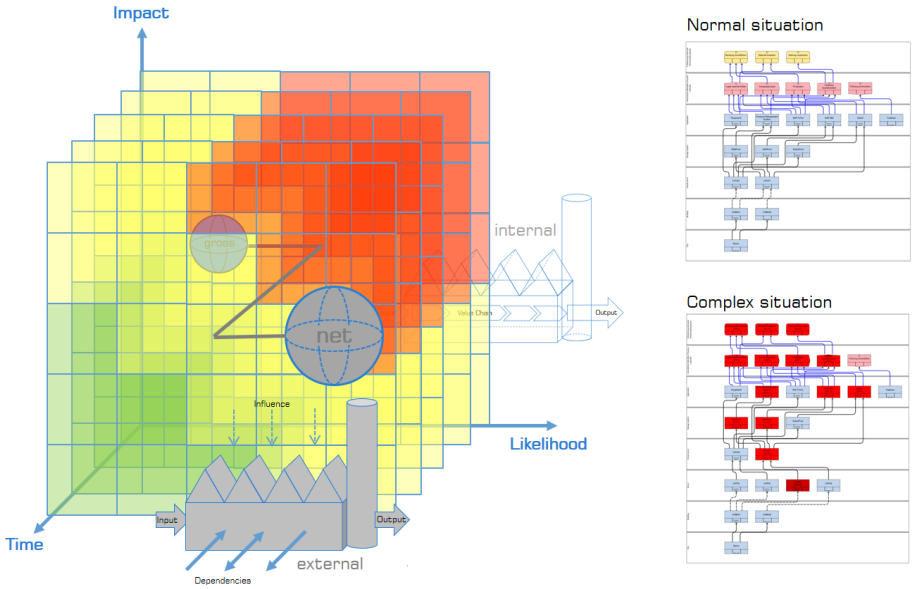

Fig. 4 Risk dependency evaluation.

With a risk dependency evaluation, the risk shift and risk dependency shift can be additionally documented, analyzed and visualized over time.

If necessary, with a risk dependency evaluation, the risk shifting over time and other criteria-like dependences can be visualized and simulated. A very famous visualization is the tower because the impact of a simulation scenario can easily be understood. This is an added value to the Risk Dependency Map because the multi dimensionality is reduced.

6. Conclusions

To manage a complex situation properly additional steps and techniques are sometimes helpful and essential.

Within the context of the present paper, process technologies were analyzed in terms of complex situation paradigm. In order to obtain the final model there was design the following sequence: describing the process technologies in OOP terms, modelling the complex situation under TopEase, adding the risk dependency map in order to obtain the final image of the situation after the risk dependency evaluation.

This step sequence allows decision makers to have a bird-eye view over the entire organizational environment. Furthermore, they may decide quickly in case of emergency situation as this model/image could be easily transform into valuable input for decision-support systems.

Results stored in an Account-Model for Complex Situation can be used to enlarge the risk assessment to calculate a special Indicator for complex situations and to provide essential input for the roadmap as well as for the risk profile. All that information requires dynamic capabilities covered by system resilience governance evaluation.

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