OTSM-TRIZ PROBLEM NETWORK TECHNIQUE: APPLICATION TO THE HISTORY OF GERMAN HIGH-SPEED TRAINS

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Abstract

Research is a human activity that involves lot of intellectual instruments to solve various problems and keep the research going on in order to get theoretical result valuable for practical application. Historical research often provides analysis of problems were solved in the past along the evolution of the research subject. Research in the domain of management and investment also need analysis of this kind. Instruments based on classical TRIZ and OTSM (OTSM-TRIZ thereafter) is dedicated to deal with networks of problems and could be used for the purpose as well.

In the paper presented Network of Problems technique and shortly its application for scientific research about Investment in Innovation.

Subject of analysis was a history of German high speed trains project.

Keywords: TRIZ, OTSM, Network of problems, Investment, Innovation.

What is Network of Problems?

There is a set of main and auxiliary instruments based on OTSM and TRIZ findings [Altshuller 1969, 1973, 1984, 1986, 1991, 1999; Khomenko 1997-2000, 2005]. Problem Flow Networks Approach is one of them. Network of Problems is a first stage of problem situation analysis. It is dedicated to get overall understanding of problem situation, - a big picture. As soon as a big picture appears as a Network of Problems, it could be analysed. Usually this analysis result by set of problems that should be solved first of all. Choice of those problems is not so obvious in complex cross-disciplinary not typical (Not standard nor routine) problems. That is why Network of Problem technique was developed.

Historical research of certain investment project also need overview of a big picture of problems and their solutions during the project. It was not a goal of our research to find alternative or better solutions. That is why just fragment of OTSM Problem Flow Networks was used.

In the frame of OTSM-TRIZ approach a complex problem is considered as a Network of Problems. Depending on the specific problem situation several methods could be used to develop this network. In our case the simplest way was chosen. It is a main component of all others.

First of all relevant problems should be collected and listed. In our case it was done in the paper of Llerena and Schenk, [see Llerena and Schenk, 2005].

As soon as list of initial problem is ready we can start develop new network of Contradictions. Along this process some further problems could be discovered that were not listed. This often happened if Network of Problems is used for complex problem solving project. It is provoked by the method the network is constructing.

Here they are some general rules we use to construct Network of Problems for various projects.

1. Collect all available problems from various sources books, papers, interview by own reasoning (but then test with Specific Knowledge Experts). Describe them shortly. In some cases constructing Network of Problems could be done without the initial list of problems. Usually it is happening during OTSM problem solving coaching sessions, or various meetings and sometimes Brainstorming. In those cases as soon as problem is mentioned by participant it is discussed and linked with other problems of the network according rules provided bellow.
2. For each problem Super- and Sub- problems should be identified. At the beginning graph called Network of Problem appear as several hierarchical graphs - trees of problems and as Partial Solutions. Partial Solution is a solution that could bring at least one positive contribution into problem solving process. Partial Solution also could be considered as a system that has advantages and disadvantages. But disadvantages are sufficient enough and could not be accepted. There fore the solution could not be considered as a Final Conceptual solution.
3. Super-Problem – Sub Problem relationship we usually identify just between two and only two problems. It is just one level of the hierarchical chain of problems. This is important point of construction of the network process: a hierarchical relationship is considered just for one couple of problems. This is a way to clarify what for each Sub-problem should be solved. In turn a Sub-problem is a problem that should be solved in order to solve Super-Problem.
4. Network of problems is an oriented graph and arrows that link nodes come out of a Super-Problem into node symbolised a Sub-Problem or Partial Solution we could implement to solve the Super-problem.
5. Arrow starts form the bottom part of a Super-problem node and arrive at the top of the Sub-problem node or Partial Solution node. This link between two nodes could be read like this: In order to solve the Super-Problem the Sub-problem should be solved, - for Sub-problem node. For Partial Solution case the link between two nodes could be read like this: In order to solve the Super-Problem the Partial Solution could be implemented.
6. Some Partial solution arise a new problems. In this case Arrow going out of bottom part of the Partial Solution node and coming into top part of Problem node.
7. As soon as we post some Partial Solution to the Network of problems we should consider and post to the map bellow the Partial Solution all disadvantages of the solution presented as a Sub-problem that prevent us consider the solution as a Final Conceptual Solution to be prototyped or implemented [Khomenko N., Kucharavy D.-2002].
8. While constructing each of Hierarchical Trees of problems we should consider how nodes of each tree link to nodes of other trees if any. Eventually the set of Hierarchical Trees will start transforms into Networks of Problems to be analysed and developed further according specific application. For instance, when we apply Network of Problems for research needs to analyse problem situation or subject presented in a certain paper we could stop developing the Network soon after we stop reading the paper and analysis and further development of the network. If we carry out our research in a domain or cross-disciplinary research Network of problem should be maintained along hole research. If Network of problems is applied for problem solving, then Network of problem should be transformed into Network of Contradictions and developed further according OTSM problem solving process. [Khomenko, De Guio 2006]. If Network of problems is applied for Ph.D. project then both of above line could be applied: first for literature research and presenting state of art in the domain of Ph.D. project and then as an instrument for choosing problems for Ph.D. research and solving research problems according OTSM problem solving process.
9. While doing previous steps could appear some additional Sub- and Super-problems and partial solutions as well that were not mentioned before. Those additional Problems and Partial Solutions should be posted in appropriate place of the Network of Problems. And partial solutions should be collected and used for getting Description of Final Conceptual solution [Khomenko N., Kucharavy D.-2002].
10. Each link that comes in or out of the node should start from a separate connection point. It is not allowed to start or finish several links within one connection point. This rule is effective just for visual analysis performing by human. If the analysis is going to be done by computer we could

neglect this rule and use just one connected point. Usually at the beginning analysis is done visually by human. The more nodes and links amount is growing the more computer support is used. Today we have prototype of software to support this analysis [Khomenko, De Guio 2006].

How Network of problems was constructed for the research of investment problems during German High Speed train project.

This network is based on the information available in the paper [Llerena and Schenk, 2005]. Additional information could clarify some points and answer some questions that were generated while the Network was constructed and analysed.

In the paper presented historical overview of the project development from investment standing point. The Network of Problems we took into consideration just relations between problems and partial solutions. We did not pay lot of attention for historical aspects and time line. For us were interested case effect relationships between problems and partial solutions and how they generate new situation with new problems and new partial solutions. This is a key point of the Network of problems approach. This formalism is important for further research in order to collect and generalize previous experience and develop instruments for practice based on the generalization of the past network of problems in order to better understand modern situation and be able discuss future opportunities and changes. In the case of German High Speed project we were focused mostly on evolution of networks of problem along the project and how those problems were solved and to what new problems those solutions leaded to. Then analysis and generalisation based on previous research and individuals of experts lead us to some important hypothesis and ideas to be cheeked in follow up research about investments to a various projects. For instance one contradiction that drive investors behaviour were proposed as a hypothesis to be further developed and collect some typical way to resolve the contradiction for further research. The preliminary formulation of the contradiction investors faced with could be done this way: In the beginning investor could be very flexible to choose one of several options to invest but in the beginning of pretty innovative project usually not so lot of information available to make a good chose. And risk is high. From the other side the more Investment was done during the project the more information became available to make right choice but flexibility of investment is not as high as it was in the beginning. In other words as more investment was done into one option the more information we have to make right choice but the less flexible could be choice of the investor. In future research it could be interesting to collect typical solution for this contradiction that was done by investors and project managers in the past in order to develop them further and implement in future. Some OTSM-TRIZ base solutions were also proposed for this contradiction. And it is also subject for research about efficiency of those solutions.
Therefore we could say that application of OTSM network of Problems could be useful for research. It is helpful to make analysis of the past experience and plan next research to be done. It is also effective to propose some ideas how typical solution of the past could be improved as well as new solution could be generated by applying other techniques based on OTSM and TRIZ.
Case of German High Speed Train project is also interesting because of simultaneously were developed two innovations: incremental innovation (improvement of existing system) and radical innovation (Magnetic Levitation System). This also bring some findings about relationships of Incremental and Radical innovations and investment problems that arise the situations when in the beginning is not clear what innovation could be invested.
Some other conclusions relevant to investment problematic provided bellow.

Conclusion.

Public innovation support (e.g., research and development funding) can be oriented towards various objectives: at early stages of the innovation process, exploration of technological opportunities is sought. At later stages, public support often seeks to foster the adoption of the new technology. Even though these objectives may be distinct, they can overlap, for instance when several technologies are supported simultaneously. In this case, an essential point is to select “the right technology, at the right time”. When the supported technologies are in competition with ones previously existing on the market, the situation becomes event more intricate.

OTSM-TRIZ based Problem Network technique was useful in order to analyse the difficulties that can be encountered in such situations. In this perspective, an interesting case is provided by the history of the German high-speed train programs.

Several stages can be distinguished since the early 1970s, involving various actors in an evolving environment: in the first (1971–1977), innovations in the Magnetic Levitation (MagLev) and Wheel/Rail technologies were pursued under the sponsorship of the Federal Ministry for Research and Technology (BMFT). In 1977, the 'generic' programme was split into two separate projects. The BMFT was responsible for the further development of the Magnetic Levitation technology, while the Federal Ministry of Transports (BMV) took responsibility for the development of a more traditional Wheel/Rail system. From that time, the two projects followed separate paths. At the end of 2000, despite the maturity of the MagLev technology, the Transrapid was not adopted for the Hamburg–Berlin line. Some of the reasons given were the high costs of the technology, its small performance advantage over the existing ICE, and demand uncertainty. An alternative outlet for this technology, namely the 31.5 km Chinese project linking Pudong airport to the Long Yang road-station in Shanghai, was found only recently. In the meantime, China's announcement that a locally made MagLev train has been successfully tested shows that this country has been able to catch up, at least partially with Germany in terms of the technological know-how regarding MagLev trains.

The sequences of events that lead to the present situation as well as specific points have been documented [see Llerena and Schenk, 2005]. OTSM-TRIZ based technique described above was used for depth analysis of the interplay between these events using the Problem Network technique. This should contribute to a better understanding of the management of large projects.

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