CORVINUS UNIVERSITY of BUDAPEST

Doctoral School of Economics, Business and Informatics

THESIS COLLECITION

Mihály Attila Retek

Interactive and online scenario building and scenario analysis

Ph.D. dissertation

Supervisor:

Éva Hideg Dr. PhD,

Doctor at the Hungarian Academy of Sciences

Professor Emeritus

Budapest, 2023

Department of Economic Geography and Urban Development

Institute of Sustainable Development

THESIS COLLECITION

Mihály Attila Retek

Interactive and online scenario building and scenario analysis

Ph.D. dissertation

Supervisor:

Éva Hideg Dr. PhD,

Doctor at the Hungarian Academy of Sciences

Professor Emeritus

Contents

1 Research history and justification of the topic

Nowadays, one of the developing and very popular trends in futures field is integral futures (Hideg, 2013, 2017; Gidley, 2017; Giaoutzi and Sapio, 2013; Borch et al., 2013). This trend not only explores possible futures, but also places great emphasis on exploring and developing the possible, acceptable and desirable future concepts of the future of its research subject, with the involvement of the actors and stakeholders operating the respective field. In order to implement this in practice, the application of IT, artificial intelligence, and the Internet has increasingly come to the forefront.

In the last 20 years, several web sites have been created with the aim of supporting the development of alternative future visions and scenarios on the Internet, with many and diverse participants. Among these web sites, the most well-known, as well as offering the most unique solutions procedures, are the **Java Climate Model** (Matthews et al., 2019), **The Millennium Project** (The Millennium Project, 2019) and the **Futures Platform** (Futures Platform TM Inc., 2019). On the model web site of the Java Climate Model, the model calculation background and the relationship between the user and the model calculation are fully informatized, but informatized interactions and feedback between the users are not possible. On The Millennium Project, the background trend calculations and the feedback Delphi method are informatized, but neither the participants nor the futurist organizers have informatized access to the possible scenarios, because they have to be traditionally produced from the downloaded materials. The web site also collects the completed scenarios independently of this procedure. The Futures Platform web site operates a library of trends in the background, and then the online participants draw on them to create different scenarios individually or together. These, however, must be uploaded to the system by the users.

These interactive web sites not only perform model calculations in the background or have a collection of updated trends and scenarios, but also allow users to create their own scenarios and shape their own visions of the future using the opportunities provided by the web site under their own conditions and for their own purposes. However, these web sites can only be used effectively for occasional, sometimes independent, sub-tasks, and in them only one or a few aspects of the entire future exploration and shaping process are informatized. Compared to these solutions, my research focuses on narrowing down and clarifying the informatization task on the one hand, and on the other hand on deepening it. **In connection with the narrowing of the informatization task, I chose only the two-dimensional scenario building process widely used in integral futures, and in connection with the deepening, I chose as the subject of my research the complete informatization and interactive operation of the process.**

I studied different types of software development methodologies for the work of organizing informatization. The **waterfall model** (Royce, 1987) is a linear sequential phase model where each phase is fixed and follows one after the other. The **spiral model** (Boehm, 1986) is a risk-driven software development model approach, where the analysis of constraints and risks is emphasized in the development, and the model is built from cycles. In the **evolutionary model** (King and Kraemer, 1984), an initial solution is created in the first round, followed by continuous improvement based on feedback, which must be repeated until the product is in a suitable state. In the case of the **prototype model** (Grimm, 1998), a trial model is prepared, with the aim of helping the developers understand the problem and, based on their experience, prepare the final concept.

Among the listed models, I chose a subtype of the prototype model, the **throwaway prototype model**, and connected it to the **spiral model**. **This hybrid or integrated process was the best for solving my software development tasks.**

2 Methods used

Since my research topic was formed at the common point of contact between futures field and IT, I **considered the integral futures approach as a methodological basis, to which I developed the informatized process of two-dimensional integrated scenario building by developing and applying an informatics methodology that is similar to and maximally helps the realization of my research tasks.**

The basis of integral futures means an approach where forward-looking futurists:

- Treat the subject of the research as a complex, large open system consisting of multiple system components and connected to its environment.
- Determine the possible futures of its subject by exploring the dynamic pattern of complex, forward-looking and feedback-providing interrelationships.
- Explore, in addition to the possible futures, the acceptable/desirable futures also, by involving the actors or stakeholders comprising the integral part of the complex, large systems.

Futures field focused on foresight solves these tasks through a process of various objective and subjective methods and processes connected to each other. Due to its perception of the future, its approach and working method, this trend is called integral futures (Hideg, 2013, 2017; Gidley, 2017; Giaoutzi and Sapio, 2013; Borch et al., 2013). **The currently widely used and practically developed process of two-dimensional scenario building fully meets the methodological requirements of integral futures.**

A similar methodology can also be found in IT: the software development models, among which there are many that are sufficiently complex and at the same time flexible and adapted to the tasks to be solved. For my task solution, I therefore developed a hybrid model that enables me to arrive at the correct task solution through the correction and development system of forward-looking and feedback, as this is also a characteristic of the chosen scenario building process and also characterizes my research style. In the initial phase of the development, I used the **throwaway version of the prototype model**, during which I obtained the necessary requirements. This was necessary because I could not have prepared the requirements of a possible future system in detail, and I only had the main information at the beginning of the developments. After the sufficient amount of requirements were already given, it was appropriate for me to choose a different type of development method, which was the **spiral model**. With the help of this model, I was able to iteratively improve my process from cycle to cycle. **In this way, I created an integrated process development model, which proved to be ideal for the informatization of two-dimensional scenario building process.**

In researching my topic, I used several methods in combination. On the one hand, I studied and learned in detail the different scenario building processes and, through their comparative analysis, I selected the process that is widely used today, and I carried out its full informatization. On the other hand, I studied the informatization processes used in IT and developed a hybrid process from them that best suited the purpose of my research task and the precise execution of the research tasks to be solved. In developing the informatization process, my motivation was to be able to return to the previous phases of the process, so that through these feedbacks I could rethink, correct or rework the previous phases in order to fit the work of the following phases.

On the one hand, I became familiar with the scenario building processes based on the **studying of the literature**, and on the other hand, I also learned the selected two-dimensional scenario building process **in practice by teaching** the students of the Corvinus University of Budapest studying various futures field subjects and teaching some expert groups preparing scenarios On the other hand, I also **facilitated** the entire process of this scenario building at seminars and expert workshops.

My IT education, years of experience as a software developer, and continuous self-education provided a good basis for the process **I developed for IT method development. I was able to successfully use and combine the task-solving process organization solutions I learned in the framework of integral futures with the process I developed for software development, and thus developed the integrated model of informatized scenario building.** In my research process, my research results were born from the goal, task and feasibility ideas, i.e. setting up hypotheses and sub-hypotheses, then solving the task and its evaluation, checking the hypotheses and sub-hypotheses, and then linking it back and forth to the next sub-tasks.

The entire process is shown in Figure 2.1.

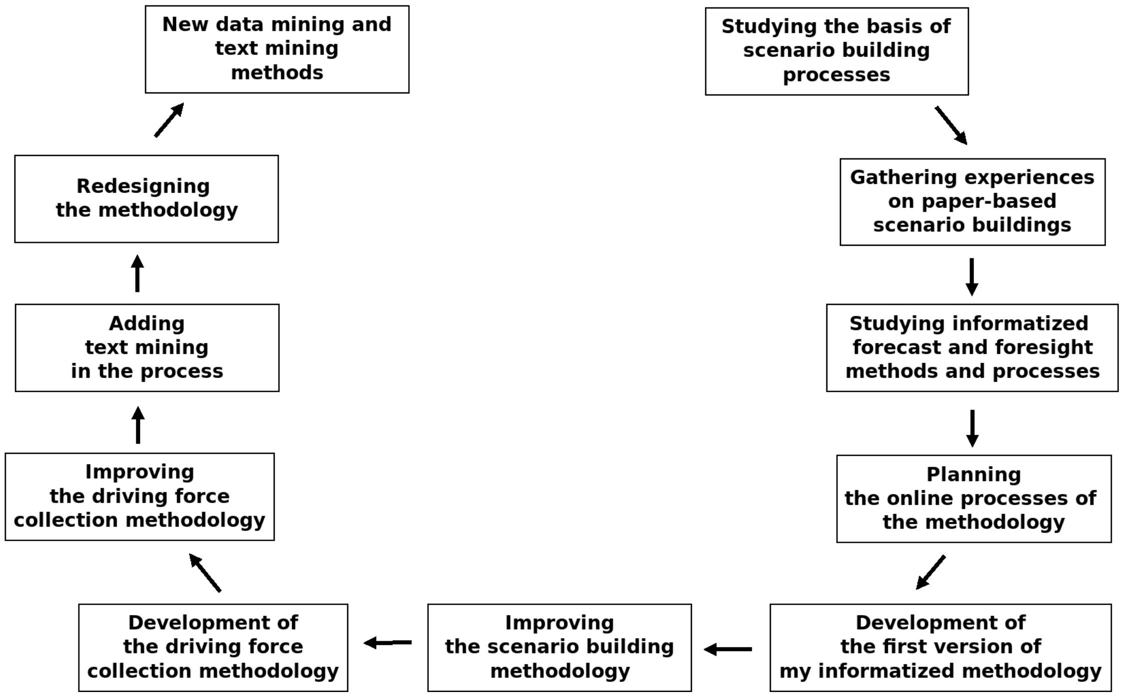

Figure 2.1: The course of the research process.

3 Results of the dissertation

I present the **informatized online integrated scenario building process** through proving my hypotheses.

3.1 Informatization of scenarios and their preparation independently of space and time

One of the current shortcomings of scenario building is that the majority of scenarios are still created on paper; as a result, scenarios are created in limited places and between limited time intervals. The other big problem is that with the currently existing informatized processes, scenarios can be created only under limited conditions. By proving my first hypothesis, I eliminated these shortcomings.

Hypothesis 1: Using my developed online scenario building process, it is possible to create individual and/or small group scenario series regardless of time and space limits.

I proved my first hypothesis in two parts. At first, I only proved how the prepared procedure was implemented on a methodological and technological level. For this, I created my own integrated online scenario building process over the course of years, and continuously improved it step by step based on tests and feedbacks. In recent years, I have further developed the process continuously by incorporating new steps and processing methods.

Second, I showed how my developed process was realized by using it independently of time and space. In the thesis, I illustrated this in detail through an example, which I used to show how the participants solve the various tasks of scenario building regardless of space and time during the scenario building process. **By applying various IT technologies and**

methods, the quality of the scenarios improved significantly, which I also supported with the results of the application of text processing methods.

3.2 Connecting scenario building processes

The two-dimensional scenario building process consists of several sub-processes: starting with the determination of different types of driving force, corrective improvement of the driving forces, preparation of the scenarios, selection of desirable scenarios, to analysis of the scenarios and feedback of the results. These are not connected or do not exist at all in the already mentioned existing and partially informatized scenario building systems. By proving my second hypothesis, I showed that the complex steps can be built on top of each other and that their connection can be effectively solved in IT.

Hypothesis 2: More complex future alternatives and scenario series can be formed by the informatized connection of several methods, and thus a complete online and informatized feedback scenario building process can be built.

During the proof of the second hypothesis, I demonstrated that effective complex future alternatives can be formed using several interconnected methods. My solution is an IT-developed integrated scenario building process, which I developed over many years. I pointed out that the process has continuously improved over time and some parts have been completely rethought based on my own research, ideas and the feedback and suggestions of the participants in the process. New steps and data processing algorithms were added to the process based on demand. These steps are currently: driver identification, correction, scenario building, polling, analysis, and feedback. Compared to other informatized solutions, it can be seen that the main goal was always to create a series of targeted scenarios. With those processes, they did not always think about a complex process from the beginning to the end of the scenario building, but only tried to provide a visually spectacular solution for certain parts of the scenario building, and the phase of informatized evaluation of the scenarios is also missing. **In contrast, the integrated process that I created sees scenario building as a unified and connected system of processes and task solving.**

3.3 Interactions in the process

In order to understand a process, it is important to identify the participants in it and the interaction relationships between them. In order to prove the third hypothesis, it was necessary to demonstrate how **humans**, **software** and **computers** are able to communicate with each other during the scenario building process.

Hypothesis 3: In the process developed by me, full-scale interactive communication between humans, softwares and computers is integrated into the entire scenario building process.

During the proof of the hypothesis, I identified and analyzed the main actor types found and interacting in the system (human, computer, software) and each of their most important combinations, which are as follows: **human – human, human – computer, human – software, computer – computer, computer – software, software – software**.

In the dissertation, I proved that **effective scenarios can only be created with full interaction between humans, software and computers**. In the various versions of my integrated process, more and more interaction between human and software appeared, which increased the efficiency of creating scenarios and made the whole process shorter and more efficient. In the course of my developments, in the process of defining the driving force, I achieved the appearance of **total interaction** between people. Although the participants can prepare the list of driving forces individually, they can constantly see each other's work and evaluate it.

In a more effective version of the scenario building phase, **grouped human (human – human) work appears**, with the help of personal interactions that take place online, the participants can create much more complex scenarios than if everyone had created their own scenario.

In my view and according to the current trends, the emerging informatization trends will lead to the fact that there will be more and more human – human interaction in the development of new scenario building processes and, due to the totality of complete software, software – software interactions will also be more prevalent.

3.4 Participants in the process

One of the shortcomings of the currently available scenario building processes is that it is difficult for the participants to do anything with the software, and it is a long, time-consuming process to acquire the skill to use it confidently. I tried to plan the process in such a way that participants with 0 experience can also prepare their possible scenarios with the process, and in the meantime their competence in creating scenarios is shaped and developed. I proved this in the fourth hypothesis.

Hypothesis 4: Participants with any level of competence are able to use the online scenario building process I developed. The knowledge and competence of the participants is constantly improving in the process of interactions.

When proving the fourth hypothesis, I identified what types of participants are found in each process during the scenario building process. Six types of human participants can be distinguished in the procedure (Sacio-Szymańska et al., 2016; Retek, 2021). These are the following: the one who develops the procedure, the one who implements the procedure, the facilitator, the expert, the stakeholder, and the decision maker/customer. Furthermore, I examined and analyzed what level of competence the individual participants must have and how the level of competence of the different participants develops during the use of the procedure.

I came to the conclusion that no experience is necessary in the use of my informatized procedure in the scenario building process for the following types of participants: facilitator, expert, stakeholder, decision maker/client. At the same time, those who have a lot of experience in the scenario building process can also create valuable scenarios (Retek, 2014, 2017).

3.5 Informatized analyses of scenarios

Nowadays, a large number of participants appear in the scenario building processes, and the scope of the prepared scenarios is also constantly increasing; therefore now it is only possible to analyze each phase of the scenario building with digital methods. That is, it is unthinkable to use non-automated methods in the interpretation, processing and decision preparation of the generated data. The participants create more and more complex and meaningful scenarios and series of scenarios digitally (Retek, 2021), it is therefore advisable to analyze, process and interpret each step of the processes using various, specially implemented and developed methods. I also formulated my fifth hypothesis based on this idea.

Hypothesis 5: The internal consistency of the large number of digitally created scenario series, their relation to the driving forces, as well as their credibility now can and should be checked and analyzed within an acceptable time frame only with text mining methods.

In connection with the proof of the hypothesis, I tried to group the analyses according to two aspects. The first type includes methods in which **the scenarios are treated as if they were independent of each other and of the driving forces**. The second type includes those methods that **map the relationships between driving forces and scenarios.**

I used and developed the following methods for the independent analyses:

- To measure readability (e.g.: Dale-Chall formula, Gunning fog index, Simple Measure of Gobbledygook), I incorporated into the process existing methods that have been well-proven by others in various fields.
- Visual frequency of words (using different types of natural language processing methods). I further developed methods used in other fields, but not yet used in analyses of scenario series, and attached them to the process.
- Analysis based on vocabulary (use of databases, e. g. Project Gutenberg, Corpus of Contemporary American English). I used already published and used databases to analyze the scenarios and attached them to the process.
- Sentiment Analysis. My own development, in which I analyzed the scenarios by combining databases.

To analyze the relationships between the scenarios, I have used and am developing the following methods:

- Visual methods (word cloud, treemap, circular donut). I further developed and implemented the visualization methods widely used these days in such a way that they would become ideal for analyzing scenarios.
- Frequency. My own idea based on an unusual idea, which I have attached to the process.
- The appearance of concepts of driving forces in the scenarios. A unique development based on my own idea.

The analysis methods I use and develop, and their various combinations, allow clients to draw quick and well-founded conclusions regarding the value and reliability of the quality of the outputs of scenario building process, taking into account their own expectations. At the same time, the analyses also help to make it possible to execute the further processing and interpretation, from a utilization point of view, of the large number of scenarios, or to filter out scenarios that are no longer relevant. **Therefore, the conclusion can be clearly drawn that the use of text processing, analysis and interpretation methods integrated into the process of online scenario building based on stakeholder participation will become more and more indispensable in the near future, and without them it is no longer possible to create high-quality and reliable scenarios today.**

4 Main references

[1] Boehm, B. (1986). A spiral model of software development and enhancement. 11(4):14–24, ISSN: 0163-5948 (print), 1943-5843 (electronic), DOI: https://doi.org/10.1145/12944.12948

[2] Borch, K., Dingli, S., and Jorgensen, M. (2013). *Participation and Interaction in Foresight: Dialogue, Dissemination and Visions*. Edward Elgar Publishing, Incorporated, ISBN: 9781781956144, https://books.google.hu/books?id=hNUmvTpD81sC

[3] Futures Platform TM Inc. (2019). Futures Platform. www.futuresplatform.com. Accessed: 2019-09-06

[4] Giaoutzi, M. and Sapio, B. (2013). *Recent Developments in Foresight Methodologies*. Complex Networks and Dynamic Systems, 1. Springer US, New York, NY, 1st ed. 2013. edition, ISBN: 1-283-91136-1

[5] Gidley, J. M. (2017). *The Future: A Very Short Introduction*. Oxford University Press, ISBN: 9780198735281, DOI: 10.1093/actrade/9780198735281.001.0001, https://doi.org/10.1093/actrade/9780198735281.001.0001

[6] Grimm, T. (1998). The human condition: A justification for rapid prototyping. *Time-Compression Technologies*, 3(3)

[7] Hideg, E. (2013). Integral futures based on the paradigm approach. *Futures*, 45:6–15, DOI:

10.1016/j.futures.2012.11.007

[8] Hideg, E. (2017). Az integrált jövőkutatás paradigmatikus kérdései és társadalomtudományi kapcsolódása. *Magyar Tudomány*, 178(9):1057–1064, http://www.matud.iif.hu/2017/09/05.htm

[9] King, J. L. and Kraemer, K. L. (1984). Evolution and organizational information systems: An assessment of nolan's stage model. *Commun. ACM*, 27(5):466–475, ISSN: 0001-0782, DOI: 10.1145/358189.358074, https://doi.org/10.1145/358189.358074

[10] Matthews, B., Infras AG, and IVIG (2019). Java Climate Model. jcm.climatemodel.info. Accessed: 2019-06-15

[11] Royce, W. W. (1987). Managing the development of large software systems: concepts and techniques. In *Proceedings of the 9th international conference on Software Engineering*, pages 328–338

[12] Sacio-Szymańska, A., Kononiuk, A., Tommei, S., Valenta, O., Hideg, E., Gaspar, J., Markovič, P., Gubová, K., and Brigita, B. (2016). The future of business in visegrad region. *European Journal of Futures Research*, 4 (1), DOI: 10.1007/s40309-016-0103-3

[13] The Millennium Project (2019). The Millennium Project website. http://www.millennium-project.org/. Accessed: 2019-11-25

5 List of own publications related to the topic

[1] Retek, M. (2021). Scenario building in an interactive environment and online communication. *Technological Forecasting and Social Change*, 162:120395, ISSN: 0040-1625, DOI: 10.1016/j.techfore.2020.120395, https://www.sciencedirect.com/science/article/pii/S004016252031221X

[2] Retek, M. (2018). The methodologies of driving forces definition on online scenario building (Hajtóerők meghatározásának módszerei a WEB-es forgatókönyv készítéshez). *A múltból átívelő jövő*, ISBN: 978-615-5904-08-0

[3] Retek, M. (2017). *Building "interactive" online scenarios based on the example of the Silk Road*, pages 477 – 500 p. Corvinus Geographia, Geopolitica, Geooeconomia, Budapest, ISBN: 978-963-503-656-1

[4] Retek, M. (2014). Scenarios of global climate change in europe. *Economica*, 7(3):107–115, https://ojs.lib.unideb.hu/economica/article/view/4409

[5] Retek, M. (2011). *A globális éghajlatváltozás interaktív és komplex forgatókönyveinek modellezése és elemzése*. BCE Jövőkutatás Tanszék, Budapest, ISBN: 9789635034710