Szent István University

Theses of the doctoral (PhD) dissertation

DECISION MECHANISMS OF BUSINESS SIMULATIONS AND LEARNING SYSTEMS

Boda Márton Attila

Gödöllő
2019

The Doctoral School

name: Doctoral School of Managemenet and Business Administration

research field: management and business administration

Head of the School: **Dr. Lakner Zoltán**

professor, Doctor of Science (MTA)

Szent István University,

Faculty of Food Science,

Department of Food Economy

Supervisor: **Dr. Ugrósdy György**

associate professor

Szent István University,

Faculty of Economics and Social Sciences

Institute of Economics, Law and Methodology

---   ---

Approval of Head of the School   Approval of Supervisor

1 WORK BACKGROUND, EXPECTED OBJECTIVES

1.1 Timeliness of the topic

One of the barriers to the spread of simulation games has disappeared with the rapid advancement of information technology and computing, and their widespread availability to the general public. The private sector has also recognized opportunities in education in this area and over the last two decades more and more companies in the field of simulation and training have been established, although it is true that in Hungary less than half of the institutes in academia used regularly business simulation games during at least one of their courses in 2018 (Boda, 2018). In international comparison, business simulation games (corresponding to the state of the art at the time) were widely used in American business schools since the 1960s (Boda, 2018).

This gap has to be filled by the Hungarian higher education, as companies expect students to enter the labor market with pragmatic thinking, and expect graduates to be able to use the theoretical knowledge. Complex business thinking, integrated, process-oriented approach, leadership and decision-making skills are among the competencies that simulation games can improve. In most cases, strategic, financial, human resources, marketing, and commercial decisions need to be made, adapting to the changing market environment and this should be done with effective teamwork. A further advantage is that students do not have to bankrupt a real business to realize that the strategy used was not competitive or sustainable, so trying different decision situations is possible without taking real financial risk. The simulation makes it possible to understand the basic financial and economic structure of companies and helps to develop a complex approach. It is important that simulation develops teamwork and managerial skills. Experience-based education provides deeper understanding and more effective way of teaching. (Boda 2013)

1.2 The objectives

1. **objective (C1):** The topic covers a very wide area from the creation of the model through its implementation to the analysis of the results. Thus the first objective is to collect, review and organize the related literature.
2. **objective (C2):** My goal is to develop an analytical method that allows decisions to be measured according to whether they are consciously based or random, heuristic, and where they can be placed on a scale between these two endpoints.
3. **objective (C3):** The aim of the research is to group user decisions by motivations, which make it possible to set up typable behaviors and rank them.
4. **objective (C4):** My goal is to set up and build a simulation model that allows players to make decisions in the same economic environment, thus their decisions become comparable. I intend to integrate the necessary elements of mathematical, computer science and economics disciplines to create the computing background for the simulation model.

Based on the stated objectives I set the following tasks.

1. Literature review of decision-related topics.
2. Taxonomic study of business simulations. Determining the scope of the dissertation.
3. Setting up a model to simulate strategic decisions of a commercial enterprise operating in an oligopolistic market.
4. Assessing the decision-making methods of business simulation players.
5. Setting up a simulation model for players' decision making methods.
6. Comparing different decision styles with simulation.
7. Looking for decision styles that make a player successful.

I did not consider it important to address the following areas: The purpose was not to evaluate a particular sample of business simulation players (e.g. a particular business simulation competition and its results), but to establish and evaluate generalizable decision situations.

1.3 Research hypotheses

In accordance with the objectives and the tasks, the following hypotheses were formulated:

1. **hypothesis (H1):** There will be well distinguishable decision styles and typeable behaviors. A generalizable model can be set up that combines the most important decision aspects of the players.
2. **hypothesis (H2):** It is possible to rank the players in terms of performance, meaning how effective each decision style is in a competition.
3. **hypothesis (H3):** Players who react more flexible are more successful in a business simulation game.
4. **hypothesis (H4):** At database level, players' decisions can be made measurable focusing on consciousness.

2 LITERATURE REVIEW

2.1 Decision

Summarizing the different definitions of decision (Kindler, 1991; Kovács, 1994; Hanyecz, 1994; Farkas, 2006; Atkinson, 1964; Harsányi, 1986; March, 1986; Hechter, 1987; Mook, 1987; Elster, 1986, 1990, 1995; Heap, 1994; Szántó, 1998; Heckathorn, 2001; Hechter – Opp – Wippler, 1990) the characteristics of decision are the following:

- central element of decision: choice, feeling of choice,
- prerequisite: minimum two alternatives for action,
- subject of decision: human,
- purpose of the decision: to maximize the (expected) consequences.

The simplest definition of decision is the choice between different alternatives. It helps to decide between alternatives if the decision maker is able to determine the expected results for each alternative as accurately as possible. By result I mean possible positive, negative or neutral state change, and even the lack of change. In addition to the expected results, probabilities of occurrence need to be assigned.

2.2 Rationality

„In logic, valid reasoning is called rational, that is, logical and consistent." (Kádár-Tóth, 2012:313) Consistency, as acting in accordance with the long-term plan, is treated as a minimum condition of rationality, since it is characteristic of all interpretations of rationality, but there are more detailed interpretations with more specific elements. Therefore, rationality as consistency is the concept of rationality in the broadest sense, and other interpretations are within this framework.

The rational decision-maker of classical economics maximizes its utility function, that is, it follows the principle of individual rationality. In my opinion, the importance of homo oeconomicus is not the selfish profit-maximizing behavior, but its adherence to rationality. Homo oeconomicus behaves logically and consistently during profit maximization. Based on this homo oeconomicus can be a basis in theoretical assumptions. In my research I have developed a simulation model based on consistent players, and partly by this I also argue the importance of homo oeconomicus, besides knowing and acknowledging its flaws that represent reality.

According to Simon, the rational decision-making model makes unrealistic assumptions about the cognitive abilities of decision-makers. Both their cognitive abilities and the information available are limited. Accordingly, decision makers are unable to maximize their utility function. Decision-makers are thus satisfied with making sufficiently good decisions. Human rationality is fundamentally limited, according to Simon. (Zsolnai, 1998)

Simon explored problems arising from the contradiction between normative decision-making theories and practical observations, focusing primarily on production processes and corporate decisions. Simon (1947, 1956) argued that only bounded rationality prevails.

Golovics (2015) notes that Simon's (1991) theory of bounded rationality also contributed to an understanding of decision-making processes within the organization. As individuals' capabilities are recognized as having cognitive limitations, in practice, they seek to establish organizational frameworks for rational decision-making rather than seeking to maximize choices between alternatives. The development of task management rules creates a rather complex structure within an organization that aims to turn decision-making processes into routine activities. (Jones 1999, Golovics 2015: 165)

The process of trying to achieve rationality by creating structure and framework for rational decisions rather than rationality in individual decisions itself is called procedural rationality.

Tversky and Kahneman focused on decisions under risk and uncertainty. The basic premise of their findings is that people do not follow rational considerations of expected utility and violate statistical principles, instead using heuristics in their judgments (Kahneman & Tversky, 1973; Tversky & Kahneman, 1974; Kahneman et al., 1982; Kahneman & Tversky, 1996; Hámori, 2003).

The Prospect Theory of Kahneman and Tversky (1979) is a descriptive model because the theory tries to model the actual behavior of people instead of using the optimal decisions of normative models. In their research about Prospect Theory they describe three heuristics which are the framing effect, the reflection effect and the certainty effect.

2.3 Game theory

Game theory focuses on decision problems and their solutions. With the help of game theory, the possible and expected consequences of the interaction between the players can be explored and presented. (Molnár & Szidarovszky, 2011)

A well-known example is the Prisoner's Dilemma, first raised by Flood and Drescher in 1950 and then a small crime scene was added by Tucker, hence the name of the dilemma (Mérő, 1996, 1998). In the Prisoner's Dilemma, prisoners are offered charges separately. A prisoner assumes anything about his companion's decision; if he is selfish enough the best decision is to betray his companion. The prisoner dilemma is intended primarily to show that the rationality expected at the community level is not realized because of individual rationality considerations; from my point of view, the important thing is to think with the opponent's head.

The repeated prisoner dilemma became known through the joint work of Axelrod and Hamilton (1981). On the one hand, the framework story of prisoners has been replaced by living organisms that compete with each other for fertility and survival through the evolution of wildlife. In this game, a higher payout means more chances of survival, and more offspring being born and raised. The second change is that we are not talking about a single game, but an iterated version of it, in which the number of turns is uncertain, so it is not known in advance which is the last move. This change has added an important consequence: the co-operation between selfish players has appeared. Based on their computer based analysis, Axelrod and Hamilton concluded that different forms of cooperation were

more profitable (Guerra-Pujol, 2013). In Axelrod's two prisoner dilemma competitions, the Tit-for-Tat strategy won, which first cooperated and then copied his opponent's previous round decision. Rapoport et al. (2015) pointed out that the success of the TFT strategy in the Axelrod prisoner's dilemma competitions was primarily due to the rules of the tournament (payout matrix values and the format of the tournament).

2.4   Business simulation

Simulation is a simplified representation of reality, which, with mathematical basis, is able to give the result of certain decisions made for certain situations. A business simulation game is in the group of simulation games where the purpose of the game is determined by economic goals and their main advantage is that we can do certain simulated events without real financial risk.

Ruohomaki's (1995) definition of simulations has a broader meaning. She says that simulation does not necessarily have to simplify reality, but it must represent it. It can be an abstract, simplified version or an accelerated version of a process. It is an important component of displaying behavioral similarity to the operation of the original system. The simulation game combines these qualities with the characteristics of the game (e.g. racing, collaboration, rules, players, roles, etc.). A game becomes a simulation game if its rules apply to an empirical model of reality. (Greco, 2013)

2.4.1   Experiential learning

Kolb (1984) notes that any learning outcome requires active experience (Lawrence, 2013). Furthermore, Hirsch (1996) points out that effective teachers always take a variety of approaches, and treating one method as superior can be extremely disadvantageous (Lawrence, 2013). Kolb and Fry (1975) find that games and simulations are suitable for providing experiential learning in managerial training (Greco et al., 2013). Later, Kolb (1984) develops a model of experiential learning that consists of four, cyclically repeated steps.

Kolb's model of experiential learning is a repeating cycle. The experiential learning process begins with some new experience. This can be the detection, reading, listening, etc. of any new information. This is followed by the processing of this information, the process of understanding. The third step is the generalization of the material being understood and its transfer to future situations. In the fourth stage, the information learned from the first three steps is put into practice and applied in a new situation. This application results in repeated experiences and continues the cycle described, incorporating previously understood and learned knowledge. (Tóth, 2011)

2.4.2   Limitations of the business simulation method

In a comprehensive study, Wellington et al (2010) examined 160 studies. Those studies measured the effect of simulations on the tests' results written at the end of school-year by pupils. Based on these measurements they found that in 46.9% of the cases simulation-based lectures were more effective than traditional forms of teaching. 16.9% of the studies said that traditional ones were more effective and in 36.3% of the cases, there was no significant difference in the results perceived. (Gold, 2015)

Simulation alone is only a tool. Success depends mainly on the application. Therefore, the isolated development of business simulations cannot succeed, it is necessary to continuously improve the educational methodology that can be linked to it, and to provide an opportunity for trainers and simulation practitioners to learn it. (Boda, 2017)

2.4.3   The importance of business simulation software in education

Hungarian education is often criticized for not meeting the demands of the labor market. Hungarian education has traditionally followed the Prussian educational system. Domestic education, founded by Maria Theresa with the aim of meeting the needs of an absolutist state, has not yet embraced the

needs of the 21st century, and continues to rely primarily on lexical knowledge transfer, while skills development and the application of knowledge are becoming increasingly important. However, as a result of automatization coming in next decades, jobs based on lexical knowledge are most at risk.

A World Economic Forum study (Schwab & Samans, 2016) looks at how the ten most important skills and competences highly valued in the labor market develop over the medium term. According to the report, the 3 most important skills in the world of work in 2020 will be complex problem solving, critical thinking and creativity.

2.4.4 Rationality measurements in business simulation games

Lukosch et al (2018) state we can represent rational choices and model behavior in simulation games. Business simulations can provide a sufficient environment to measure rationality if they are expressly developed with this aim, but if so, it is more like a task solving test (Sleboda & Sokolowska, 2017).

Usually learning benefits of business simulations are measured with self-reported surveys (e.g. Dhatsuwan & Precharattana, 2016, Wellington, Hutchinson & Faria, 2017) which may lack the objective perspective. Also, students are usually asked to reflect on their own decision-making abilities e.g., were they rational or intuitive decision makers (e.g. Costin et al, 2018) which is still a very subjective methodology. As Reeder (2013) states, actors compared to observers are more likely to explain their own behavior rational by citing good reasons for their actions, due to they are motivated to portray themselves as rational; which strengthens there is a need for objective solutions.

Assessing with digital simulation games have the fundamental advantage of data can be gathered unobtrusively (Mayer, 2018, Mayer et al, 2014), although there is a little evidence that these data would be used to evaluate the rationality of players' decisions.

The primary focus of participant assessments in business simulation games is how players' skills were developed (e.g. Teach & Patel, 2007). There are a very few studies deal with the decision process itself. For example, Rashid et al (1988) proposed an expert system model for making "first-period" pricing decisions.

Musshoff et al (2011) analyzed boundedly rational behavior (Simon, 1956) in business simulation games. The study provided a results-based analysis instead of a decision-process based solution (i.e. authors compared achieved results with achievable results if uncertainty in case of price forecasts would be eliminated).

Kuperman's (2009) findings suggest that in business simulations, searching for strategies that satisfy normative standards would be justifiable: As students were able to learn from experience and improve their policies, it was expected that they should eventually discover an appropriate policy that maximizes their payoffs. However, in the research, the majority of the subjects failed to reach optimal strategies. "It appears that there is a preferred bias toward choosing particular types of strategies that satisfy normative standards, even though these strategies produce lower payoffs."

The "degree of rationality and the degree of decision-making efficiency depend on the situational and structural context of the decision making […], indicating that professional decisions are generally conducted more along rational reasoning than private decisions (Neuert et al, 2015)." This statement also indicates that decisions made in a business simulation environment should be assumed more rational than the private ones. Although Wolfe (2016) notes that rational decisions in business simulations are affected by the level of engagement: "Those who were completely engaged in the experience obtained superior economic results and created strategies and implementations that were rational, goal-oriented and correct for the simulation's modeled competitive environment." Which

implies that one key element of rationality is engagement, and based on this, rationality measurements could lead to active participation/engagement assessments too.

3   MATERIALS AND METHODOLOGY

Business simulation games are often played by teams. It is not uncommon for teams to have serious disagreements about their decision because of the different views of team members.

Hurta (2013) quoting Klein (2004) notes that „basically everyone has attitudes, that determine behavior toward objects, beings, and situations. Because attitudes are not visible, audible or perceptible, they can be inferred from observed behavior or actions."

Based on my experiences, the reasons for different decision-making styles have to be found in different attitudes. Therefore, in the dissertation, I discuss this issue on several levels so that I can finally measure the success of each strategy and attitude through a specific business simulation game. Since attitudes can be inferred from observable behaviors, therefore I will examine behavioral dimensions, habits instead of attitudes.

It is important to mention that when I start my research, I use the experience I have gained over several years, first as a player (twice in university courses and in many domestic business simulation competitions and finals) and later as a co-founder of a company which develops business simulations and also as a developer of business simulations. With the business simulation we created, we held several national and international competitions, which also help us to understand the processes from a different perspective what we experienced as players. These experiences are not published researches, but they are an essential background for the preparation of the dissertation.

The research has been done at multiple levels. The first is a qualitative research study built on interviews with various finalists in different business simulation competitions. This study analyzes the thinking of good players, their decision-making methods, and the experiences of a Hungarian simulation developer and competition organizer company. The purpose of these interviews was exploratory research. As a result of interviews and personal experience, I finally found that the players have specific strategic ideas, but on the one hand they are very diverse and on the other hand they are always tailored to the situation. It is also true that players usually use mixed strategies. Therefore, it is difficult to say with database analysis what motivated the player's decisions in a given situation. This is especially true because our tournaments are all organized in the format of team competition, which means that the decisions made are not reflect a single person's thoughts. Therefore, creating an artificial environment where players decide on clear strategies is justified. Of course, virtual players have the ability to adapt to their opponents but players can only decide based on their stated attitudes. To do this, I created a questionnaire that measures the player's attitudes. Based on the measured attitudes, I have created virtual players, agents, who make decisions in specific situations instead of real players. Virtual Agents made decisions in the MAXIMULATION business simulation game, which evaluates them to make their strategies comparable. A total of 151 virtual agents made decisions in 9331 simulated games.

3.1   Qualitative interviews
The topic of qualitative interviews

The purpose of qualitative interviews was to conduct exploratory research on the following topics:

- categorizing the decisions of business simulation players and making them measurable;
- determination of motivations behind decisions and analysing the decision processes;
- defining typical decision-making behaviors.

Subjects of the research

During the research I wanted to interview 2 target groups:

- University or college students with business interest who have attended a business simulation training or business simulation competition.
- Business simulation developers or competition organizers, to get ideas on how to measure rationality at database level.

The aim of the research

The purpose of qualitative research is to get to know the thinking of players using business simulation. It is necessary to clarify where the line between consciously based and random decisions lies. This requires an examination of definitions of rational decisions, which I did in the literature review. If I use the permissive definition, then essentially the player is rational when (s)he makes the decisions needed to achieve his/her goals and they are consistent.

There is no single solution in a business simulation game, there are many ways to succeed a virtual enterprise. From this point of view, it is important to look at what points of judgment each player has in their decision and what attitudes they have at each point of decision.

Justification for the choice of research technique / methodology

Both focus group and interview techniques are suitable for such an exploratory research where the undestanding of players' thinking is needed. However decisions can be made in groups I chose to do personal interviews because I wanted to get to know a broader range of thinking, including the individual motivations behind each decision.

I have planned 6 interviews to get to know player thinking. 5 interviews with players and 1 with manager of a company that develops business simulation games and organizes business simulation competitions. The purpose of this was to gain a deeper insight into player motivations and to gain a comprehensive external view of decision-makers' behavior.

The business simulation competitions in which the interviewees took part have the following common features:

- Computer-assisted simulation;
- Multiplayer, the opponents are students, not AI;
- Turn-based, where players make decisions any time until the deadline of the given round and lack new information until results are not simulated based on the decisions;
- The competitions consist of several levels: qualifiers, semi-finals, final;
- The competitions required both personal presence and there were also online rounds;
- Strategic decisions are to be made;
- Players' companies are starting from the same, initial position;
- The competition is divided into different markets, where 4-8 teams present one market.
- The simulated market environment is oligopolistic with 5-6 teams per market.
- Teams take the role of management of manufacturing and / or commercial companies.

Outline of the interviews

I wanted to set up the interviews relatively freely, but larger topics were identified and thought-provoking questions were formulated. The major subject blocks are:

- Introduction (relevant background information)
- Defining decision
- Defining rationality
- Forming alternatives and the choice between alternatives
- The decision process in the simulation
- The applied strategies in the simulation
- Possibilities of measuring rationality in the simulation.

3.2 Questionnaire analysis of decision-making behavioral dimensions

Based on the results of the qualitative research it is possible to determine the main points of logic and thought along which the players, and especially the better players make decisions, but this may not generalizable on the players as a whole. Therefore, I planned to obtain quantifiable data through a larger sample survey. Using the quantitative method, my goal is to collect statistically significant data on what types of players can be classified and how they would behave in each situation.

Based on my observations and interviews, players tend to use a mixed strategy, therefore, by simply analyzing a simulation's database of decisions and their outcomes, it is not likely to be clear how a player chooses between action alternatives, in a given situation. Accordingly, I first map the motivations of the players and the considerations they make in each situation. Later, putting their strategies into a simulation makes it possible to compare different strategic ideas.

In the case of attitude research, I analyse the decision-making attitude, and specifically the behavior in certain situations. It is necessary to determine what decision points the research should focus on, that is, first, how a virtual agent decides. Based on my own experiences and qualitative interviews, I built the logic of the virtual agents and set up the required input values based on the questionnaires.

The following behavioral dimensions were identified to be mapped:

- risk appetite,
- attitude towards pricing,
- attitude towards marketing activities,
- competitor analysis methods used,
- attitude towards market share,
- responding to competitor strategies in different situations:
    - direction of reaction,
    - degree of reaction.

There are two ways to assess how players decide in certain situations. First is to analyze how they actually made a decision in a particular situation, and second to ask them how they would decide in a particular situation. The former is observation and the other is an interview technique (e.g. a questionnaire).

The advantage of observation is that it shows a real decision, the disadvantage is that the motivation behind the decision remains unknown. The player types are more likely to operate with a mixed strategy rather than purely one strategy. Therefore, assessing decision-making mechanism is difficult to determine solely on the basis of simulation results. It is necessary to conduct a questionnaire survey

with the players. In the research I combined these two elements so that the respondents could make decisions in a simplified version of the simulation and then answer the questions in the questionnaire after the game. There were also opportunity to answer the questionnaire without playing. If the respondent answered the questions after the game, the game ID was automatically attached to the questionnaire, while maintaining the possibility of anonymity. However, it is important to note that playing the game does not meet the research value expected from the observation, since during a simulation competition or course players spend much more time making individual decisions. Here, the game only helps to put the post-game questions into context.

3.3   Building artificial intelligence for simulation decisions

After exploring the player types and decision behavior dimensions, I use simulation modeling to see how different decision making styles competes against each other.

The MAXIMULATION business simulation software used for analysis provides a framework for players: different decisions made by players are collected and evaluated in the simulation. Normally, the opponents are real players, thus for the dissertation virtual players' thinking had to be created.

3.3.1   Preparing decision inputs, filtering the base table

In order to determine how an agent decides, we first have to list the sets of information, tables that a real player can access about his opponents. If this information is available, it should be determined which of these data is used by the virtual agent and to what extent.

The information available to players can be divided to two big data tables:

- The „decision table", which contains all decisions made by the players.
- The „result table", which contains the simulated results.

These two tables give all the information needed to make a decision:

- previous decisions of the player,
- previous decisions made by opponents,
- result table for previous rounds.

The data of these information can be further broken down according to whether or not that information is available to the decision maker. Obviously, the player can only make definitive statements based on the information (s)he sees. Invisible data from competitors results in uncertainty, as well as the fact that players' future decisions are unknown, and also much of the data is available refers to the past. The only future-related data is the demand forecast.

All the needed information is entered for the virtual player to make decision:

- In the starting round this is the initial state and the player's decision attitudes.
- In later rounds these are the result data of the previous round and the player's previous decisions.

The player makes decisions based on this information.

3.3.2   Decision inputs

In order to determine how a player should make decisions, it is first necessary to clearly see what decisions the player should make. Once the scope of decisions to be made has been determined, it is necessary to categorize them according which decision is affected by the analysis of competitors and which is only internal company data.

The decision inputs are described below. In the game, there are three products that are traded by the virtual company, and most of the decisions are directly or indirectly related to these products. Decisions directly related to the products are pricing, stocking and marketing.

The total number of decision inputs is 17, which are the follows:

- Purchase and sales: 6 decisions (pricing and purchasing decisions for 3 products).
- Marketing: 4 decisions (setting total marketing budget and weight for 3 products).
- Human resources: 4 decisions (change of salary and headcount of blue and white collar employees).
- Financing: 1 decision (loan).
- Pick-pack points: 1 decision (changing the number of pick-pack points which are functioning as sales channel).
- Projects: 1 decision (starting or not a specific project).

Of these 17 decisions, the following are not directly or significantly depend on the decisions of other teams:

- financing,
- projects.

For the next 15 decision inputs, I simplify the decision making in the model in HR decisions, which means the virtual players cannot change wages, only the headcount changes are available and also I disable in the simulation that the job market is finite, so I essentially exclude these decision inputs (4 inputs). Thus, the range of decision inputs to model is the following:

- purchase, sales and pricing decision of 3 products (low, medium and premium products; number of decision inputs: 6),
- setting of marketing budget and weights (number of decision inputs: 4),
- and setting the number of pick-pack points (number of decision inputs: 1).

A rational decision maker would combine these 3 factors to always focus on where the smallest investment can achieve the desired effect, or the best possible impact with the planned spending.

However, the difficulty of the task is not only that the players do not know the expected decision of the opponents, but that they do not know the exact effect of these factors. The impact of these factors can be collected empirically, and it is difficult to distinguish which factor has exactly its effect. Therefore, players choose a combined solution, where they make an intuitive decision to prioritize between the decision factors.

Ultimately, which of these three factors is more important to a player will depend on subjective judgment. This requires, among other things, an examination of the decision-making behavioral dimensions.

The detailed structure of the model is discussed in the results section, since it is necessary to use the questionnaire answers to present it.

4   RESULTS

The results are based on three interrelated methodological elements. First, I collected information about decision-making situations in business simulations through interviews. After that I examined the different decision situations by questionnaire analysis, and finally, based on the previous two method, I created a decision simulation model, and ran 9331 simulations.

4.1 Structure of the decision making model based on the results of interviews and questionnaires

I created a decision process simulation that fits into the decisions to be made in MAXIMULATION business simulation.

The purpose of the questionnaire was to create virtual players with different playing styles based on the answers, and then simulate these different playing styles by competing against each other and provide a basis for further analysis.

Table 1: Player types based on the questionnaire responses with regard to flexibility of reactions to opponents' actions and intended market share

Strategy based on intended market share		Flexibility of reactions	Type
DEFENSIVE Strategy	defensive strategy	flexible	TYPE1
		not flexible	TYPE2
Focus on 1 product category	focus on premium products	flexible	TYPE3
		not flexible	TYPE4
	focus on medium category products	flexible	TYPE5
		not flexible	TYPE6
	focus on low category products	flexible	TYPE7
		not flexible	TYPE8
Focus on 2 product categories	focus on low and medium categories	flexible	TYPE9
		not flexible	TYPE10
	focus on low and premium categories	flexible	TYPE11
		not flexible	TYPE12
	focus on medium and premium categories	flexible	TYPE13
		not flexible	TYPE14
EXPANSIVE Strategy	expansive strategy	flexible	TYPE15
		not flexible	TYPE16

Source: own editing based on questionnaire responses and interviews

The 105 respondents who completed the questionnaire were not homogeneous, nor was it a goal. The 105 answers were grouped by decision styles. The grouping was built on the interviews. The first grouping factor was the planned market share. Based on the qualitative interviews and the questionnaire responses, I divided the answers into two categories, which were defined as defensive and expansive strategy. Since three product categories had to be categorized by market share, the planned market share strategy was classified into eight categories, which I combined into four larger categories.

I added another dimension to the above categorization, which is the flexibility of reactivity to changes of opponents and the environment. According to this, the eight categories expanded to sixteen, with each having a flexible and a not flexible version (Table 1).

4.1.1 Decisions of the virtual players in the first round

In the first round, due to the lack of decision history, the opponents' decisions cannot be taken into account yet, but their expected decisions are. Therefore, in the questionnaire, I collected information about the decisions with a double purpose. Accordingly, the questions are structured in such a way that the first round of decisions can be mapped and the next round of decision-making mechanisms

set up. For the first round, information had to be collected for the decision inputs presented in the materials and methods section.

Based on the responses about projected market share, with a simple subtraction is easy to get the number of products to purchase:

$$[planned\ sales] - [closing\ stock\ in\ previous\ period] = [stock\ to\ order]$$

As regards pricing, the majority of respondents also made a difference between the premium and low category products. While the average margins reported for low category products were 29.4%, for medium products 33.6% and for premium products 40.3%. While 13.3% of the respondents were in the 41-60% profit margin for low category products, 17.1% for medium products, and 50.5% for premium products. Respondents' attitude towards marketing decisions was also surveyed. The question raised that there is a correlation between pricing and marketing budget. However, when examining this, there was no correlation between the price of each product and the weight of marketing within the budget, or the average price of the product and the total marketing expenditure. In human resource decisions, I used the simplification that wages couldn't be changed by any virtual player during the game. The players could change only the number of employees, but this was calculated by an automatic formula and was not dependent on any decision-making habit. The calculation was based on the difference between the current capacity and the one needed in the next period. Financing, like human resource decisions, was automatic. During the testing of the questionnaire it became clear that in the case of sales channel it is not possible to assess the question in such a way that it can be answered unambiguously, so in this case I did not ask about the pick-pack points but respondents' answers were matched with former decisions made by real players. Since there was no close correlation with any of the factors, some randomness was found in determining the opening numbers for each sales point. There are three kinds of projects that can be launched in the game, the positive benefits of them are not exactly known, only the cost is known. Only one project can be launched in one period. Which ones to start or even starting one were chosen by the virtual players randomly.

4.1.2   Decisions in subsequent periods: virtual players' reaction to competitors' actions
In this subchapter, I present how the flexible and not flexible reactivity to changes is actually applied during the simulations. It is important that this process is only considered from the second round, as there is no decision history in the first round that virtual players can react to.

An important component of responsiveness to changes of the environment is the applied competitor analysis method. I surveyed what parameters should be taken into account when comparing with competitors. Based on the answers, I divided competitor analysis methods into three groups in the simulation:

- follows the best performing competitor,
- follows the best performing competitors ranked by each product,
- follows the best competitors ranked by each product choosing from the best performing competitors.

Every second respondent indicated that (s)he makes product-based analyzes, which may mean incorporating to some extent the decisions of three different competitors at the same time. One in five respondents answered that they would follow the best performing competitor. In this case, the player first identifies who (s)he considers to be the best competitor in the market according to some criteria and examines this opponent's decisions. In this case, contrary to the previous strategy, the player may also incorporate the opponent's decisions of a product for which the competitor has not performed

well in the market. The third category is a combination of the previous two. First, the player examines who are the three strongest competitors based on his/her ranking criteria, then goes on to analyze these competitors product by product then build the information into his/her own decisions.

Based on the interview responses and my own experience, I have come to the conclusion that during comparing their competitors players choose profit or market share as a measure of success. It is also important to note that this choice may change during the game. Although there was a slight increase over time in the weight of profit, overall, respondents were almost indifferent to the two factors. Of course, there is a standard deviation of the values that will be better represented by the results of the simulation. Later, I refer to this choice (i.e. what is more important when ranking opponents: the profit or market share) as ranking method.

How virtual players rank others consists of three different elements. These are competitor analysis method, ranking method and previous round result data. The competitor analysis method refers to the comparison method, the ranking method tells us what is the ratio of the importance of market share and profit as a ranking criteria, while the previous round data provides figures that are essential for the calculations. In the calculations, for each competitor, earnings after tax, total revenue, revenue per product, cost of sold goods per product, and marketing cost per product are used.

In the best-competitor approach, companies are ranked according to profit and market share (or net sales), and then the two numbers are aggregated, weighted by profit and net sales weights. By ranking the resulting sums, we get which is the strongest companies in the market by the value judgment of a given virtual player.

In the best-by-product method, the sorting mechanism is similar to the one above, with the difference of sorting made not on company but product level. Firm-level profit also includes fixed costs, which are not involved in the calculations in this case by virtual players only variable costs attributable to products. Product-level profit is thus calculated as follows:

$$[profit\ of\ the\ product] = [revenue\ of\ the\ product] - [COGS] - [marketing\ of\ the\ prod.]$$

In the combined ranking method the comparison is product-based after choosing only the top-performing competitors to compare.

4.1.2.1 Responding to the market: the planned market share, and the planned inventory

If there was a closing stock remaining, the projected market share is formed by analyzing the projected market share in the previous round and the actual results and using the player's flexibility factor. That means subtracting half of the difference between actual and planned numbers multiplied by the player's flexibility factor, which can vary from 0 to 1.2 depending on the player's attitude. Thus, in practice, the previously planned market share can be reduced by 0-60% of the difference between the previously planned and actual numbers. Expressed by the formula:

$$\begin{bmatrix} planned \\ market \\ share \end{bmatrix} = \begin{bmatrix} planned \\ market \\ share\ in \\ the\ previous \\ round \end{bmatrix} - \left\{ \left(\begin{bmatrix} actual \\ market \\ share \end{bmatrix} - \begin{bmatrix} planned \\ market \\ share\ in \\ the\ previous \\ round \end{bmatrix} \right) \div 2 \right\} \times \begin{bmatrix} player's \\ flexibility \\ factor \end{bmatrix}$$

If there is no closing stock, the player will increase the planned market share. In this case, the previously planned market share will be increased based on the player's flexibility attitude, which in this case may range from 0 to + 54.8 percent. Expressed by the formula:

$$\begin{bmatrix} planned \\ market \\ share \end{bmatrix} = \begin{bmatrix} planned \\ market \\ share\ in \\ the\ previous \\ round \end{bmatrix} \times \left(1 + \sqrt{\begin{bmatrix} player's \\ flexibility \\ factor \end{bmatrix}} \right)$$

The player's flexibility factor is a random number between the upper and lower limits of the given dimension.

4.1.2.2 Responding to pricing decisions

In pricing, the decision-maker uses the pricing of the player selected as an opponent should be followed in case of a particular product. In this case, the decision maker adjusts the difference between the previously applied price and the price of the selected competitor according to the player's flexibility attitude. Expressed by formula:

$$\begin{bmatrix} pricing\ of \\ the\ player \end{bmatrix} = \begin{bmatrix} pricing\ of \\ the\ player \\ in\ the\ previous \\ round \end{bmatrix} + \left(\begin{bmatrix} previous \\ round \\ pricing\ of\ the \\ competitor \\ selected\ to \\ follow \end{bmatrix} - \begin{bmatrix} pricing\ of \\ the\ player \\ in\ the\ previous \\ round \end{bmatrix} \right) \times \begin{bmatrix} player's \\ flexibility \\ attitude \end{bmatrix}$$

Replaced by a specific example, if a player applied a 40% price while the player to follow 20%, and that player's flexibility attitude is inflexible, then the player is going to set its price between 34% and 38%:

$$\begin{bmatrix} pricing\ of \\ the\ player \end{bmatrix} = 40\% + (20\% - 40\%) \times \begin{bmatrix} random\ number\ between: 0.1\ and\ 0.3 \\ in\ this\ example\ 0.2 \end{bmatrix} = 36\%$$

If the projected market share is below 10 percent or the closing stock is less than 5 percent of the goods were available for sale, the player applies a strategy of positioning its products higher if the player earlier used higher pricing than the player's competitor. In practice, this means that the player does not approach the competitor with the number calculated above, but move in the opposite direction to the price by half. In the example used in the previous case, this would mean that the player would apply a profit margin of between 41% and 43% in the next round.

4.1.2.3 Responding to marketing decisions

Marketing has the same decision-making mechanism as pricing, with the difference that previous marketing decisions are the initial data, and at the end, marketing budget needs to be weighted across products.

4.1.2.4 Responding to decisions regarding sales channel

The pricing mechanism is also used for pick-pack points, except that only firm-level comparisons are possible when ranking opponents, so players are always analyzing firm-level profitability and then make decisions based on their flexibility attitude.

4.2   Results of the simulation

Simulation is used in multiplayer mode, so the competitive spirit is an important part of the game. The competition was also an important element in the simulations run for the dissertation. Virtual

players were compared on several levels in a knockout system. There were 46656 virtual players competing in 7776 markets during the qualifiers. From each market the players who were ranked first place based on profit qualified for the next round (Figure 1). In the next round 7776 players competed in 1296 games, at the next level there were 216 games and so on until the final with six players. Multilevel competition is of the utmost importance because players have to compete in markets of different composition. This can best be traced to the fact that while there were 151 virtual players in the first round of the 7776 market, 32 of them did not qualify to the next round because they did not win in any market. That is, in the next round, there will be only 119 virtual players. In the third round, there were only 41 decision-making styles. There were 11 in the fourth round containing 36 games, 3 in the fifth round with 6 games and in the final round also 3 types of decision styles were competing.

In the following analyzes, I will refer to each level as follows:

- 7776 games, 46656 players: pre-qualifying round,
- 1296 games, 7776 players: qualifing round,
- 216 games, 1296 players: sixteenth finals,
- 36 games, 216 players: quarterfinals,
- 6 games, 36 players: semifinals,
- 1 games, 6 players: final.
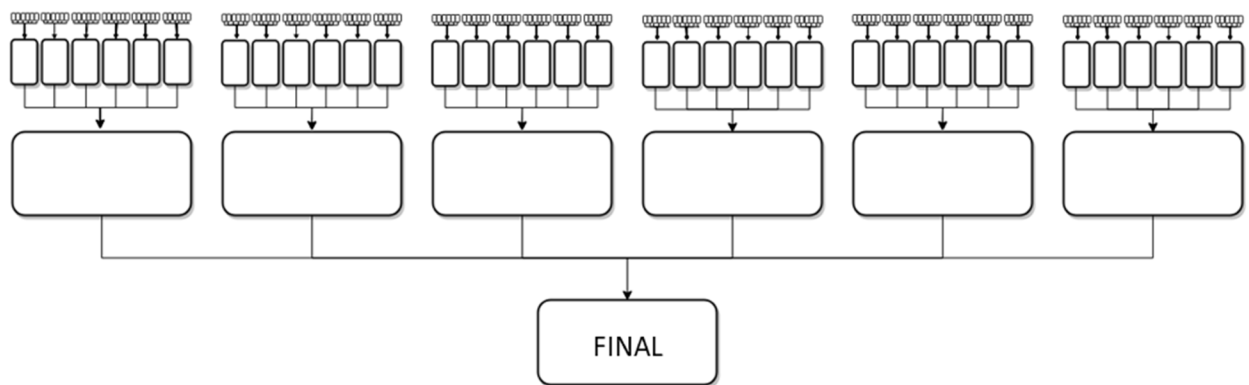
Figure 1: Demonstration of the single-elimination knockout system used in the simulation: first placed players qualify for the next round competing in six-player markets. The figure shows a competition of 1296 teams in 216 markets

Source: own editing

4.2.1   Fail and success in the pre-qualifying round: looking for the causes
I did not find a clear correlation between advancement and any decision factor, result data. I expect that advancement depends mostly on the strategy opponents follow, how similar or different they are compared to the strategy of a particular team. I will analyze this issue below, first through the 7776 games of the pre-qualifying round.

Table 2 shows the results achieved by each player in proportion to the total number of games they played. While it is interesting how each player performed, how successful they were, it is more important to look at what opponents they did well or badly. To do this, I ranked the results obtained in a matrix where I compared the rankings achieved by each player in the presence of other players in the market (Figure 2).

Table 2: Rankings of players in the pre-qualifying round as a percentage of 1-6 places, highlighting the results of the first, middle and last five players

	Player	1st place	2nd place	3rd place	4th place	5th place	6th place
1	PLAYER94	98,9%	1,1%	0,0%	0,0%	0,0%	0,0%
2	PLAYER5	89,6%	9,6%	0,7%	0,0%	0,0%	0,0%
3	PLAYER118	86,2%	12,4%	1,2%	0,2%	0,0%	0,0%
4	PLAYER55	79,4%	17,9%	2,5%	0,2%	0,0%	0,0%
5	PLAYER45	78,1%	18,9%	2,8%	0,2%	0,0%	0,0%
74	PLAYER7	6,3%	17,0%	23,9%	27,2%	20,0%	5,7%
75	PLAYER106	6,3%	14,9%	23,1%	31,4%	17,8%	6,5%
76	PLAYER16	6,3%	19,0%	27,6%	26,9%	15,6%	4,6%
77	PLAYER129	6,1%	15,0%	25,1%	28,1%	18,8%	6,7%
78	PLAYER27	4,6%	12,7%	20,5%	24,3%	24,1%	13,7%
147	PLAYER133	0,0%	1,0%	2,7%	15,0%	37,4%	43,8%
148	PLAYER134	0,0%	0,0%	1,0%	4,2%	25,3%	69,5%
149	PLAYER135	0,0%	0,2%	1,6%	3,9%	25,2%	69,1%
150	PLAYER141	0,0%	0,0%	1,5%	7,1%	32,5%	59,0%
151	PLAYER145	0,0%	0,2%	1,5%	5,4%	21,3%	71,6%

Source: results of the simulation, own editing

Selected from the data in Figure 2, Figure 3 shows the relationship between PLAYER1 and PLAYER3. The matrix shows the results to the proportion of games played with each other. For example, when PLAYER3 finished second and PLAYER1 finished fifth, it covered 9.7 percent of the games where they both participated. In addition, the figure shows how successful were the two players when they both played on the same market in the same time. For example, PLAYER3 won 16.1 percent of the games played together, compared with 8.3 percent for PLAYER1.

	PLAYER3-1	PLAYER3-2	PLAYER3-3	PLAYER3-4	PLAYER3-5	PLAYER3-6	PLAYER4-1	PLAYER4-2	PLAYER4-3	PLAYER4-4	PLAYER4-5	PLAYER4-6
PLAYER1-1	0	1	0	0	1	0	0	0	1	0	0	1
PLAYER1-2	2	0	2	2	0	0	0	0	0	3	0	0
PLAYER1-3	1	0	0	3	1	1	0	1	0	1	2	2
PLAYER1-4	0	2	5	0	1	1	0	0	1	0	0	3
PLAYER1-5	1	3	1	0	0	0	0	0	1	5	0	2
PLAYER1-6	1	1	0	1	0	0	0	1	0	0	0	0
PLAYER2-1	0	0	1	1	1	0	0	0	0	0	2	4
PLAYER2-2	2	0	3	4	0	1	0	0	1	1	7	4
PLAYER2-3	1	2	0	7	1	0	0	0	0	0	2	7
PLAYER2-4	0	0	0	0	2	0	0	0	0	0	0	1
PLAYER2-5	0	1	0	1	0	0	0	0	0	0	0	0
PLAYER2-6	0	0	0	0	0	0	0	0	0	0	0	0

Figure 2: Detail of the matrix of virtual players' results in the pre-qualifying round, where PLAYERx-y represents x for the player and y for the reached position

Source: results of the simulation, own editing

	PLAYER3-1	PLAYER3-2	PLAYER3-3	PLAYER3-4	PLAYER3-5	PLAYER3-6	
PLAYER1-1	0%	3%	0%	0%	3%	0%	8,3%
PLAYER1-2	6%	0%	6%	6%	0%	0%	12,5%
PLAYER1-3	3%	0%	0%	10%	3%	3%	25,0%
PLAYER1-4	0%	6%	16%	0%	3%	3%	16,7%
PLAYER1-5	3%	10%	3%	0%	0%	0%	33,3%
PLAYER1-6	3%	3%	0%	3%	0%	0%	4,2%
	16,1%	22,6%	25,8%	19,4%	9,7%	6,5%	

Figure 3: Example from the matrix summarizing the results of games simulated in the pre-qualifying round, where the proportion of results is shown when both player were participated in the same market (PLAYERx-y represents x for the player and y for the reached position)

Source: results of the simulation, own editing

These values will have actual meaning if we analyze the results that these players achieved without the competitor in that comparison, so that we can see the impact of playing with that player. Table 3 shows that PLAYER3 had a positive impact on the performance of PLAYER1 when they participated in a particular market together.

Table 3: Demonstration of players' impact on other players' performance through the example of PLAYER1 and PLAYER3: PLAYER1's performance with or without the participation of PLAYER3 on the same market

	results **with** the participation of PLAYER3 on the same market	results **without** the participation of PLAYER3 on the same market
PLAYER1, 1st place	8.3%	3.4%
PLAYER1, 2nd place	12.5%	11.4%
PLAYER1, 3rd place	25.0%	24.4%
PLAYER1, 4th place	16.7%	26.2%
PLAYER1, 5th place	33.3%	24.8%
PLAYER1, 6th place	4.2%	9.8%

Source: results of the simulation, own editing

For all the players, I examined how the players affected other players' performance. Six cases could occur ("+" for positive impact, "-" for negative impact and "n" for no impact):

- unknown: no contact between the two players
- symbiosis: both players benefit from each other's presence, win-win situation (++)
- king-making: one player gives the other an advantage while (s)he performs worse (+ - or - +)
- kamikaze: both players are disadvantaged in the presence of the other (--)
- unilateral effect
  - king-making: one player is assisted by the presence of the other (n + or + n)
  - weakening: one player weakens the other's performance but is not affected by the other player (n- or -n)
- no effect: there is no effect on each other's performance (nn)

In 7.1% of the cases there were no connection between players (unknown). Subdividing the remainder, the distribution of relationships between players is shown in Figure 4.
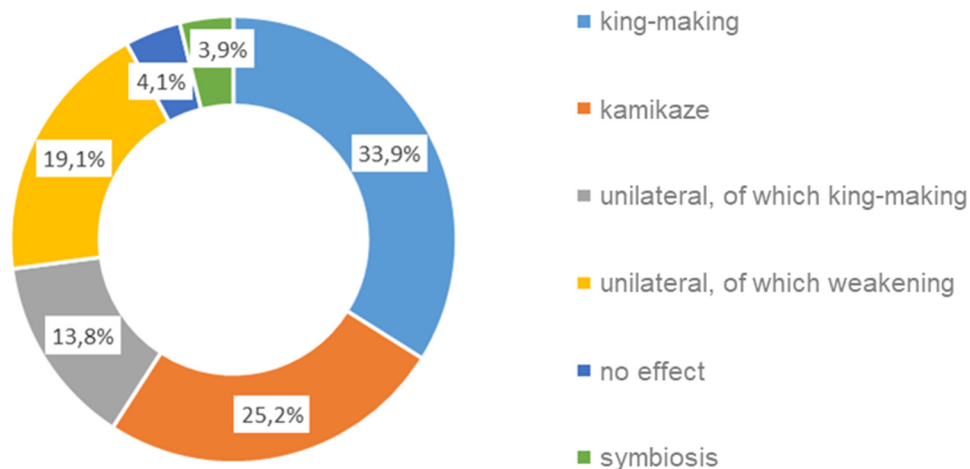
Figure 4: Breakdown by category of relationship between two players in the simulated pre-qualifying round

Source: results of the simulation, own editing

Four-fifths of the players were at least once positively affected by the king-making effect or the unilateral version of it. There is also a high correlation between average positions and the positive side of king-making ($r = .94$, $p < .001$) and the ratio of first places to the positive side of king-making ($r = .88$, $p < .001$). The same is true on the other side: king makers are less likely to qualify to the next round of the competition ($r = .83$, $p < .001$). The other types of effects are not so clearly matched with effectiveness. The correlation between the kamikaze relationship type and the average positions is weaker than medium ($r = .44$, $p < .001$). The same is true for the symbiosis relationship type, where there is a weak correlation between the relationship type and average rank ($r = .34$, $p < .001$).

There is a strong correlation ($r = .86$, $p < .001$) between the ratio of first places achieved by a given type and the ratio of the effect of king-making. Figure 5 is a detail of the matrix where the results of the sixteen types is shown when they competed with each other. For example by examining the relationship between TYPE2 and TYPE5 based on the data in the figure, it can be stated that 8.4 percent of the games played with the participation of the other type were won by TYPE2 players and TYPE5 players were finished second. It can also be stated that 34.1 percent of the games with the participation of TYPE5 players were won by TYPE2 players, which is slightly better than against TYPE4 and TYPE6 players.

I examined how each player performed in the presence of particular players, and type of players. According to this, I distinguished six types of effects, of which „king-making" relationship had a clear effect on the chances of winning. There is also a clear ranking between each player type. However, it is important to underline that these comments were true in the context of the pre-qualifying round, so it is important to carry on the analysis at next levels of the competition.

		TYPE4						TYPE5						TYPE6				
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
TYPE1	1	0,0%	3,1%	2,5%	3,2%	3,0%	0,9%	0,0%	4,6%	3,9%	3,1%	4,3%	1,7%	0,0%	2,7%	3,1%	3,5%	2,7%	2,0%
	2	4,8%	0,0%	6,0%	5,1%	4,9%	2,0%	5,7%	0,0%	3,2%	4,4%	4,8%	2,5%	6,7%	0,0%	4,1%	4,3%	5,0%	2,8%
	3	6,4%	3,9%	0,0%	4,8%	4,7%	2,6%	4,2%	5,9%	0,0%	3,8%	4,4%	3,4%	7,1%	5,2%	0,0%	4,0%	4,0%	3,3%
	4	5,8%	3,7%	4,4%	0,0%	5,2%	1,4%	4,2%	3,7%	4,3%	0,0%	3,2%	2,1%	4,3%	3,4%	3,4%	0,0%	3,2%	3,2%
	5	3,7%	2,8%	2,2%	3,2%	0,0%	1,7%	3,6%	2,0%	4,1%	3,0%	0,0%	3,6%	4,9%	3,5%	2,8%	2,9%	0,0%	2,8%
	6	1,7%	1,5%	2,1%	1,4%	1,4%	0,0%	1,4%	1,4%	1,1%	0,6%	2,0%	0,0%	1,7%	1,2%	0,7%	0,8%	0,8%	0,0%
TYPE2	1	0,0%	7,2%	7,3%	7,9%	6,3%	3,3%	0,0%	8,4%	7,8%	6,0%	6,5%	5,4%	0,0%	8,3%	7,0%	7,1%	6,0%	4,2%
	2	3,6%	0,0%	3,5%	3,8%	2,2%	1,3%	4,1%	0,0%	4,0%	3,5%	2,5%	1,4%	5,7%	0,0%	3,5%	3,8%	2,7%	2,4%
	3	2,9%	2,9%	0,0%	3,3%	2,8%	1,4%	3,0%	3,5%	0,0%	2,5%	2,0%	1,9%	3,3%	2,3%	0,0%	2,1%	2,3%	1,6%
	4	3,1%	3,0%	3,6%	0,0%	1,7%	1,4%	2,6%	4,0%	2,8%	0,0%	2,4%	1,1%	4,2%	3,0%	2,5%	0,0%	2,8%	1,7%
	5	3,2%	2,6%	3,7%	4,4%	0,0%	1,4%	2,0%	3,2%	2,3%	2,6%	0,0%	1,7%	3,3%	2,8%	2,4%	2,4%	0,0%	1,7%
	6	2,4%	1,2%	2,5%	3,0%	3,0%	0,0%	1,9%	3,0%	2,8%	2,0%	2,9%	0,0%	2,9%	3,0%	1,4%	1,7%	1,9%	0,0%

Figure 5: Distribution of results achieved by player types in pre-qualifying round by competitor and position for each type

Source: results of the simulation, own editing

4.2.2 Fail and success in the qualifying round: deviations from the pre-qualifying round's results

Examining the results of the pre-qualifying round, it has already been shown that it is not the used strategy that determines the chances of success, but the effectiveness of the strategy used in relation to specific opponents. It is worth comparing the winning percentage of each player according to the results in the pre-qualifying and qualifying rounds. For example while Table 2 showed that PLAYER94 won all the markets except for one in which PLAYER94 competed, the qualifying round had different results in markets with different player combination. PLAYER94 was still the second best player to win, but won only 59.6 percent of the games (Table 4). Five of the first six players were the same in pre-qualifying and qualifying rounds, only their ranks changed. After them, however, the order of the players changed significantly. The degree to which these players emerge from the market has declined significantly. While the top five virtual players in the pre-qualifying round won an average of 86.4 percent of their games, the top five players in the qualifying round have won only 55.2 percent of their games on average. Table 4 shows the proportion of the top five players' positions in the qualifying round.

The number of different decision styles has been significantly reduced in this round. 119 players started the qualifiers and 41 players succeed to qualify to the next level. For the next 216 games and 1296 players, there is a significant concentration in the various decision styles. Eight players (19.5 percent of the players) account for 78.3 percent of the players.

In the qualifying markets, I also examined the interactions between players in different market compositions. The big change compared to the pre-qualifying round is that there were far fewer „kingmaker" players. While in the pre-qualifying round, four-fifths of the players were at least once

positively affected by king-making or its unilateral version, in the qualifying round it was only 36.1 percent.

Table 4: Results of the top five players in the qualifying round, ranked based on the ratio of first places by each player

	Player	1st place	2nd place	3rd place	4th place	5th place	6th place
1	PLAYER5	77,4%	18,7%	3,3%	0,6%	0,0%	0,0%
2	PLAYER94	59,6%	26,6%	10,6%	2,1%	1,1%	0,0%
3	PLAYER55	57,9%	31,0%	10,2%	0,9%	0,0%	0,0%
4	PLAYER118	49,9%	35,0%	10,8%	3,8%	0,5%	0,0%
5	PLAYER12	34,4%	33,2%	21,2%	10,0%	1,2%	0,0%

Source: results of the simulation, own editing

There is also a weak correlation between the average positions and the positive side of the king-making ($r = .34$, $p < .002$), and the ratio of first places to the positive side of the king-making ($r = .34$, $p < .002$). There was no significant relationship with other factors (even at $p < .05$ level). Since, despite the weak relationship, king-making showed the strongest relationship with the ratio of game-winning, so I continued to study this by player types. The correlation has weakened compared to the pre-qualifying round, but is still moderately strong between the ratio of wins and the ratio of king-making ($r = .55$, $p < .03$). The success of each type (ratio of winning) and their ranking have significantly changed compared to the pre-qualifying round. The types in the first and last two places remained unchanged, but there was a major rearrangement between them.

4.2.2.1 Evolution of player composition from round to round
In the third round, 1296 players competed in 216 markets. This 1296 players consisted of 41 different styles of decision making, which is the number of different players who won a market in the previous qualifying round. The highest number of players in this round is PLAYER5 with 281 players. They are more than the simulated markets in this round, so it was allowed to compete for more players with the same decision style in the same market. In the fourth round of thirty-six games, there were 11 decision styles. In the fifth round of six games, there were three decision styles with 36 players, and these three final decision styles were in the final too.

4.2.3   Success by player type
Table 5 shows what percentage of players of a particular type in the previous round made it to the next round. It is important to display the data in this way, as this will make it clear which particular player type has been favored or disadvantaged by the particular features of the round.

In the pre-qualifying markets, each type was distributed almost evenly as competitors. This was a requirement in the draw for that round. Accordingly, the data in the qualifying column in Table 5 shows how players perform in a market composed of 16 types. Under these circumstances, TYPE2 players were the best performers, with one-third advanced, while worst was TYPE14 players, where almost all (99.5 percent) players were eliminated. The qualifying round also apparently favored TYPE2 players, with half of the games (49.6 percent) being won by this type of player. The composition of competitors has changed considerably. While in the first round almost every competitor could have an opponent with almost equal chances (the probability of getting each type of competitor as an opponent was between 6.0% and 6.7%), there were significant differences in the next rounds.

Table 5: Percentage of players of a given type qualified from the previous round to the next round

	qualifying round	sixteenth finals	quarterfinals	semifinals	final
TYPE1	17,8%	17,2%	28,4%	24,0%	16,7%
TYPE2	33,3%	49,6%	25,2%	10,1%	16,7%
TYPE3	21,7%	4,1%	0,0%	-	-
TYPE4	22,8%	17,6%	39,8%	40,0%	16,7%
TYPE5	19,9%	7,0%	0,0%	-	-
TYPE6	25,0%	28,8%	4,6%	0,0%	-
TYPE7	26,8%	13,1%	1,0%	0,0%	-
TYPE8	25,2%	7,2%	3,8%	0,0%	-
TYPE9	10,6%	3,6%	0,0%	-	-
TYPE10	11,2%	0,6%	0,0%	-	-
TYPE11	14,0%	10,9%	2,3%	0,0%	-
TYPE12	4,4%	0,0%	-	-	-
TYPE13	9,6%	1,8%	0,0%	-	-
TYPE14	0,5%	0,0%	-	-	-
TYPE15	12,6%	14,6%	9,1%	0,0%	-
TYPE16	11,8%	19,1%	11,9%	0,0%	-

Source: results of the simulation, own editing

Similarly for TYPE8 players it can be observed, that while in the first round the quarter of these players have made it to the next round, tha success ratio of TYPE8 players fall to 7.2% in the next round. This was also due to the fact that, in the first round, the odds of competing against each type varied between 6.0% and 6.7%, while in the next round it was more likely (13.0%) to be the opponent of the previous round's best performer TYPE2 players. 0.23 percent was the chance of being the opponent of a TYPE14 player, which type's players was weaker than TYPE8 players.

4.2.4   The impact of players' competitor analysis methods on success

I analyzed what style attributes each player had and how they influenced their performance. During the simulation, 9331 games were played. These included 151 different players representing 16 different playing styles. The 16 styles are distinguished by their intended market share, product orientation and degree of flexibility to changes.

In my model of virtual players reacting to competitors' actions, players first ranked their opponents according to a specific method, then reacted to the decisions of the chosen competitor to the extent of their behavioral dimensions. Below, I examine to what extent the decision-making behavioral dimension contributed to the success.

Players took into account two factors in their ranking process. Whether the product or company-level approach, or a combination of both was the basis for the analysis when an agent ranked its opponents was called as competitor analysis method. I called it ranking method when the player decided that profit or market share was more important by ranking the competitors. This may have changed depending on which stage the game is in. Table 6 shows the success rate of different competitor analysis methods over the entire competition. Product-level analysis may appear to have yielded better results, but relationship analysis showed only weak correlation (H = 0.168).

Table 6: Distribution of competitor analysis methods by success rate across the entire competition (9331 games)

	Product-level	Company-level	Combined
1st place	22.1%	14.5%	10.9%
2nd place	17.6%	16.8%	15.2%
3rd place	16.3%	16.2%	17.7%
4th place	15.6%	15.6%	19.2%
5th place	14.4%	17.8%	18.8%
6th place	13.9%	19.2%	18.1%
	100.0%	100.0%	100.0%

Source: results of the simulation, own editing

The weight of profit versus market share in competitor rankings was weakly correlated with the market-by-market rankings in the second round ($r = .10$, $p < .001$), then gradually weakened further. In the third and fourth decision rounds the relationship was even weaker ($r = .06$, $p < .001$, $r = .09$, $p < .001$).

The relationship between market rankings and the flexibility of reactions to competitors' actions was also weak ($r = .11$, $p < .001$).

Overall, both in case of competitor analysis and ranking methods is valid to state that it is not a generally identifiable method or decision point that is decisive for the success, but the composition of a given market.

4.3 Confirmation or refutation of research hypotheses

Based on the results of my doctoral dissertation and related research, I evaluate the hypotheses formulated in the introduction of the dissertation as follows.

1. hypothesis (H1): There will be well distinguishable decision styles and typeable behaviors. A generalizable model can be set up that combines the most important decision aspects of the players.
Based on my experience as a business simulation player, and later as a business simulation competition organizer and simulation trainer, as well as the results of interviews and questionnaires, I was able to highlight the main points that made it possible to set up 16 different types of players. I have classified these types according to the players' intended market share, the degree of flexibility to change, and their product focus. It is also important how players rank their opponents. There are two basic elements to this. One decides which method to rank opponents on, and the other assigns weights to compare each factor. Players either analyze market results by product, or make comparative calculations per player, or a mixture of them (selecting the top 3 companies and then doing product level analysis). After selecting the comparison method, the two determinants by which players are ranked during the comparison were profit and market share achieved. The extent to how profit or market share is taken into account depends on the stage of the game. Therefore, **I consider the H1 hypothesis to be validated.**

2. hypothesis (H2): It is possible to rank the players in terms of performance, meaning how effective each decision style is in a competition.

Based on the results of the 9331 simulations presented in the dissertation, it can be stated that in a given competition, in certain circumstances players can be ranked. However, it is also true that the strategy used cannot be examined solely in itself, but depends on the strategy used by the opponents.

It is not generally possible to speak of a winning strategy under all circumstances. Therefore, **the H2 hypothesis was only partially confirmed**.

3. hypothesis (H3): Players who react more flexible are more successful in a business simulation game.

Based on a questionnaire survey, I created virtual players with 151 different decision styles representing a mix of flexible and inflexible players. These players competed against each other in 9331 games, in six-player markets of various compositions. The relationship between rankings and flexibility of reactions was weak ($r = .11$, $p < .001$), so **I reject the H3 hypothesis**.

4. hypothesis (H4): At database level, players' decisions can be made measurable focusing on consciousness.

Since based on the results of the dissertation, I believe that the thinking of the players should be evaluated, so I do not consider rationality to be measurable only at the database level in the current form of simulation. This will in any case require additions that collect data on the player's thinking. However, based on this data, it is possible to make objective analyzes that will advise the player when his / her decisions and his / her aims are not consistent with each other.

The evaluation of awareness primarily requires qualitative analytical work by the educator. It is an important educational role to assess student decision motivation. One way to do this is to ask players as „management" for a presentation to be held for the audience who are representing the „owners" of the company. They present the main cornerstones of their company operations and report on how their ideas have been realized. The advantage of this method is that other players can ask questions, so that different views can be debated and participants can learn from each other. Therefore, **the H4 hypothesis was only partially confirmed (Table 7)**.

Table 7: Confirmation or refutation of research hypotheses

Nr of the hypothesis	Content of the hypothesis	Result
H1	There will be well distinguishable decision styles and typeable behaviors. A generalizable model can be set up that combines the most important decision aspects of the players.	confirmed
H2	It is possible to rank the players in terms of performance, meaning how effective each decision style is in a competition.	partially confirmed
H3	Players who react more flexible are more successful in a business simulation game.	rejected
H4	At database level, players' decisions can be made measurable focusing on consciousness.	partially confirmed

Source: own analyses

4.4 New scientific results

1. I found that the significance of homo oeconomicus is not the selfish profit-maximizing behavior, but its adherence to rationality. Homo oeconomicus behaves logically and consistently during profit maximization. Based on this homo oeconomicus can be a basis in theoretical assumptions.

2. I have found that it is not necessary to distinguish between rational decision-making and norm-driven action, because on the one hand, they are confused in the mind of the decision-

maker and generally cannot separate them and on the other hand comply with or violating the social norms leads to a result which can be made part of rational consideration.

3. I surveyed the decision-making mechanisms of participants in business simulation competitions. I have identified the most important style features of decisions. These are attitude towards market share, responsiveness to opponents' decisions, different types of competitor rankings, and changes in the importance of market analysis factors (profit or market share) according to the actual round of the game.

4. I surveyed the occurrences of different decisions in certain decision situations, then categorized them and created virtual agents, creating 151 different decision styles and 16 different decision types.

5. Using the surveyed decision-making behavioral dimensions and decision-making style features, a self-developed program was developed to simulate decision-making mechanisms that was coupled with a (partially) self-developed business simulation game that simulates competition between commercial firms in an oligopolistic market. The success of different strategies depends almost exclusively on the market composition.

5 CONCLUSIONS, RECOMMENDATIONS

From the results of my doctoral dissertation and the related research I made the following conclusions:

1. In business simulation games, it can be generally stated that players determine an important point in their own decision-making process and then adjust the rest of the company's decisions to this first decision.

2. During the analysis, a distinction should be made between first-round and further-round strategies.

3. In terms of market share, two main strategies can be distinguished: defensive and expansive. Reaction to opponents also moves on a flexible-inflexible scale. It has also been found that different methods are used by players when comparing opponents.

4. Based on my own experiences and the interviews, one of the difficulties of measuring rational decisions in simulation games is that the goal-oriented behavior can evolve during play as well.

5. An important observation is that, based on interviews with both the players and the simulation developer interviewees, the experience of the interviewees was that the players generally behave inflexible, meaning that their initial strategy largely determines their subsequent decisions.

6. During a competition, players do not know their opponents before starting a game, but they still use different methods to estimate their expected performance (e.g. rank the players by institute). In different levels of the competition, players of different strengths are automatically assumed, so their strategy is adjusted accordingly (they expect an ever-declining share).

7. Extreme risk-taking is significantly limited by teamwork.

8. There are several models of rationality that a player can fit, there is no one good solution.

9. When measuring rationality, the process and thinking of players should be analysed instead of only analysing the results. Decisions should be considered in the light of whether or not it was consistent with the player's goals. The goals of the player must be compared with the goals of the game and drawn to the player's attention if (s)he has set inappropriate goals.

10. The rate of use of business simulations in business education in Hungary lags behind that of American business schools, where they have relied heavily on this method since the 1960s. Progress has been made in recent years, but in 2018 only 45% of institutions that have a significant weight in Hungarian business education or have a significant business/economic profile used business simulation games in their educational activities. Hungarian business simulation based education has room for growth not only in quantity but also in quality. In my experience, while in the past the method was not known enough by academia, nowadays issue of financing brings barrier of spreading business simulations in academia.

11. Since as I primarily talking about educational simulations, it is very important from a pedagogical point of view that there is a strong affirmation that there is no universally applicable successful decision scheme, but the player should always adapt to the given situation. As more and more simulations appear in education, it is important to draw educators' attention to evaluate results flexible so that they do not argue for a specific strategy but place it in a broader context.

12. Successful play requires not only flexibility but also the ability to innovate. In the simulation model, players only responded to previous round decisions of their opponents, but basically lacked the ability to radically renew their strategy, meaning that in a given situation, not only would a player follow or outperform competitors, but would set up a brand new strategy not independent of the situation, but independent of each opponent. It is often the case that copying and following competitors is not warranted, for example, when there is little difference between opponents and they make similar decisions, a radically different decision can result in a decisive difference between the competitors and the player.

13. In any case, optimization of relative position is required in a business simulation competition where the goal is to achieve the best possible position for a given player in a given market based on a specific benchmarking system. However, this leads to the fact that a player with a high loss in absolute numbers can succeed if (s)he has the lowest loss in the market. Therefore, it may be worth considering other criteria for advancement, where profit is not the basis for advancement, but the marginal condition. For example, the largest market share is the benchmark and thus the criteria for qualifying the next level, but loss-making firms automatically fall out of the competition.

14. Further area of research might be to run analyzes of real-world player decisions, including the possibility of human error and mixed strategy decisions. However, this requires a sufficient number of samples.

6   SUMMARY

In the literature review definitions of decision making were classified and the evolution of rationality in economics were analyzed. Game theory was also an emphasized part of the literature. Focusing on business simulations, particular attention was paid to the taxonomic classification of business simulations. The historical overview, the current usage level of business simulations and how business simulations fit into the Hungarian education were also analyzed. The effectiveness of feedback was highlighted as a key factor in increasing the learning outcome available through business simulations. The current state of rationality measures in business simulation games were presented.

The main goal of the literature review was to explore the basis of rationality and effeciency measures can be used in the simulation model and to formulate a conclusion that the player is considered rational if the player makes the decisions needed to achieve his or her goals, and they are consistent. This thought was the cornerstone of further analysis and modeling.

Following a comprehensive literature review, I based my findings on three main methodological elements. My previous business simulation experiences gathered as participant of business simulation competitions, student and later as competition organizer and business simulation developer have been complemented with the insights, comments and experiences of successful business simulation players and developers/competition organizers. Six interviews were made with them. The information I have obtained during the interviews was used to create a questionnaire survey. With the survey answers my goal was to use them to form virtual players. These virtual players or agents were placed in a (partially) self-developed business simulation game where they competed against each other on different markets with different players. There were 151 types of decision-making styles that were classified into 16 types of decisions. The decisions were made by the agents in the light of previous results, according to their own decision-making style using predetermined decision model. The self-made decision-making model was built in the framework of the dissertation. During the analysis I searched for factors that help a player to win.

To evaluate the results it is worth recalling the famous competition of Axelrod (1980) presented in the literature review. The goal of the competition was to compare the strategies applied in the prisoner's dilemma. Programs sent by researchers who published about the prisoner's dilemma were competed against each other. The competition had a round-robin style where everyone played against each opponent (and even with themselves). In the competition, the achieved score and not the number of winning matches gave the final result, which led to the victory of the tit-for-tat (TFT) strategy. In the work that criticizes the results, Rapoport et al. (2015) pointed out that the victory of the TFT strategy was largely due to the execution and the scoring of the competition, so it was not in itself the overall success of the strategy.

The main virtue of this thesis is that the data clearly show that not the individual strategies guarantee success, but the players' composition of the given market influence success. Although it was possible to announce a winner in the simulations ran by me, or to be able to talk about "kingmaker" players under certain circumstances, such as in the Rapoport analysis, they are not winners or kingmaker-players in general, but they become those due to the given composition of competitors.

7 LITERATURE

[1]. Atkinson, J. W. (1964): An Introduction to Motivation. Princeton: Van Nostrand (In: Farkas, 2006 im.)

[2]. Axelrod, R. (1980): Effective choice in the Prisoner's Dilemma. *Journal of Conflict Resolution*. 24(1), 3–25. pp. doi:10.1177/002200278002400101

[3]. Axelrod, R. – Hamilton, W. D. (1981): The Evolution of Cooperation. *Science*. 21(1), 1390-1396. pp. online elérhetőség: http://www-personal.umich.edu/~axe/research/Axelrod%20and%20Hamilton%20EC%201981.pdf [letöltve: 2018-09-30]

[4]. Boda M. A. (2018): Current Usage Levels of Computer-Based Business Simulation Games in Academia Focusing Business Education of Hungary. *International Conference on Business and Management Sciences: New Challenges in Theory and Practice 25th Anniversary of the Doctoral School of Management and Business Administration*. Szent István University, Szent István Egyetem, Gödöllő, 2018. október 25-26.

[5]. Boda M. A. (2017): Szemléletformálás új generációs üzleti szimulációkkal. *Digitális Konferencia 2017. Digitális Tér*, ELTE, Budapest, 2017. november 18.

[6]. Boda M. A. (2013): A gazdasági diploma munkaerőpiaci helyzete. – Egy lépéssel közelebb a piacképesség felé üzleti szimulációs szoftverekkel. Kézirat

[7]. Costin, Y. – O'Brien, M. P. – Slattery, D. M. (2018): Using Simulation to Develop Entrepreneurial Skills and Mind-Set: An Exploratory Case Study. *International Journal of Teaching and Learning in Higher Education*. 30(1), 136-145. pp. ISSN 1812-9129

[8]. Dhatsuwan, A. – Precharattana, M. (2016): BLOCKYLAND A Cellular Automata-Based Game to Enhance Logical Thinking. *Simulation & Gaming*. 47(4), 445-464. pp. doi:10.1177/1046878116643468

[9]. Elster, J. (1986): Introduction. In: (ed.): *Rational Choice*. Oxford: Basil Blackwell, 1-33. pp. (In: Farkas, 2006 im.)

[10]. Elster, J. (1990): Selfishness and Altruism. In: J. J. Mansbridge (ed.) *Beyond Self-Interest*. Chicago: The University of Chicago Press, 44-52. pp. (In: Farkas, 2006 im.)

[11]. Elster, J. (1995): A társadalom fogaskerekei. Budapest: Osiris-Századvég Kiadó (In: Farkas, 2006 im.)

[12]. Farkas Z. (2006): A racionális cselekvés, a társadalmi cselekvés és kölcsönhatás: Társadalomelmélet 5. Miskolc: ME, 108 p. http://mek.oszk.hu/03900/03944/html/#4

[13]. Golovics J. (2015): Korlátozott racionalitás és altruizmus: behaviorizmus a közgazdaság-tudományban. *Hitelintézeti Szemle*. 14(2), 158–172. pp. online elérhetőség: http://www.hitelintezetiszemle.hu/letoltes/6-golovics.pdf [letöltve: 2017-10-24]

[14]. Gold, S. (2015): With Simulations, it is not the Wand but the Magic in the Magician: Pilot Study Enhancing and Assessing Topic-specific Student Learning Using an Economic Simulation. *Developments in Business Simulation & Experiential Exercises*. 42 online elérhetőség: https://journals.tdl.org/absel/index.php/absel/article/view/2912/2863 [letöltve: 2017-08-24]

[15]. Greco, M. – Baldissin, N. – Nonino, F. (2013): An Exploratory Taxonomy of Business Games. *Simulation & Gaming*. 44(5), 645-682. pp. doi:10.1177/1046878113501464

[16]. Guerra-Pujol, F. E. (2013): The Parable of the Prisoners. SSRN: https://ssrn.com/abstract=2281593 doi:10.2139/ssrn.2281593

[17]. Hámori B. (2003): Kísérletek és kilátások Daniel Kahneman. *Közgazdasági Szemle*. 50, 779–799. pp.

[18]. Hanyecz L. (1994): Döntéshozatal, Döntési modellek. Janus Pannonius Tudományegyetem, Közgazdaságtudományi Kar, Pécs, 168 p.

[19]. Harsányi J. K. (1986): Advances in Understanding Rational Behavior. In: J. Elster: *Rational Choice*. Oxford: Basil Blackwell, 82-107. pp. (In: Farkas, 2006 im.)

[20]. Heap, S. H. (1994): Rationality. In: S. H. Heap - M. Hollis - B. Lyons - R. Sugden - A. Weale (1994): The Theory of Choice. A Critical Guide. (1992) Oxford and Cambridge: Blackwell Publishers, 3-25. pp. (In: Farkas, 2006 im.)

[21]. Hechter, M. (1987): Principles of Group Solidarity. Los Angeles: University of California Press (In: Farkas, 2006 im.)

[22]. Hechter, M. – Opp, K.-D. – Wippler, R. (1990): Introduction. In: (ed.): Social Institutions. Their Emergence, Maintenance and Effects. New York: Walter de Gruyter, 1-9. (In: Farkas, 2006 im.)

[23]. Heckathorn, D. D. (2001): Sociological Rational Choice. In: G. Ritzer - B. Smart (ed.): Handbook of Social Theory. London, Thousand Oaks, New Delhi: Sage Publications, 270-284. pp. (In: Farkas, 2006 im.)

[24]. Hurta H. (2013): A versengő és a kooperatív vezetői attitűd a magyar kis- és középvállalkozások körében. Doktori (PhD) értekezés, Szent István Egyetem, Gazdálkodás és Szervezéstudományok Doktori Iskola, Gödöllő, online elérhetőség: https://szie.hu/file/tti/archivum/Hurta_Hilda_ertekezes.pdf [letöltve: 2018-09-05]

[25]. Jones, B. D. (1999): Bounded Rationality. *Annual Review of Political Science*. 2(1), 297-321. pp. in Golovics 2015 im.

[26]. Kádár Z. – Tóth I. J. (2012): Ráció és Utópia: In: Laczkó Sándor és Gyenge Zoltán (szerk.): *Lábjegyzetek Platónhoz 9*. Az ész Pro Philosophia Szegediensi Alapítvány, Magyar Filozófiai Társaság, Státus Kiadó Szeged, 312-323. pp.

[27]. Kahneman, D. – Slovic, P. – Tversky, A. (szerk.) (1982): Judgement under Uncertainty: Heuristics and Biases. Cambridge University Press, New York.

[28]. Kahneman, D. – Tversky, A. (1973): On the psychology of prediction. *Psychological Review*. 80(4), 237–25l. pp. online elérhetőség: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.395.3759&rep=rep1&type=pdf [letöltve: 2018-10-02]

[29]. Kahneman, D. – Tversky, A. (1979): Prospect Theory: An Analysis of Decision under Risk. *Econometrica*. 47(2), 263-292. pp.

[30]. Kahneman, D. – Tversky, A. (1996): On the reality of cognitive illusions. *Psychological Review*. 103(3), 582–591. pp. online elérhetőség: http://matt.colorado.edu/teaching/highcog/fall8/kt96.pdf [letöltve: 2018-10-02]

[31]. Kindler J. (1991): Fejezetek a döntéselméletből, Aula Kiadó (Budapest)

[32]. Klein S. (2004): Vezetés- és szervezetpszichológia, Edge 2000 Kft., Budapest, ISBN 963 202 838 4, 1-736. pp.

[33]. Kolb, D. A. (1984): Experiential learning: Experience as the source of learning and development. Englewood Cliffs, NJ: Prentice Hall

[34]. Kolb, D. A. – Fry, R. (1975): Towards an applied theory of experiential learning. In C. L. Cooper (Ed.) *Theories of group processes*. 33-58. pp. Chicago, IL: Wiley.

[35]. Kovács Z. (1994): A döntéshozatal pszichológiai háttérfolyamatai. Pszichológiai szöveggyűjtemény. Zrínyi Miklós Katonai Akadémia, Budapest.

[36]. Kuperman, R. D. (2009): Analyzing Conflict Dynamics With the Aid of an Interactive Microworld Simulator of a Fishing Dispute. *Simulation & Gaming*. 41(3), 293-315. pp. doi:10.1177/1046878109341397

[37]. Lawrence, W. K. (2013): The experience of contrasting learning styles, learning preferences, and personality types in the community college English classroom. Doktori értekezés, Northeastern University Boston, Massachusetts, online elérhetőség: http://hdl.handle.net/2047/d20004841

[38]. Lukosch, H. K. – Bekebrede, G. – Kurapati, S. – Lukosch, S. G. (2018): A Scientific Foundation of Simulation Games for the Analysis and Design of Complex Systems. *Simulation & Gaming*. 49(3), 279-314. pp. doi:10.1177/1046878118768858

[39]. Mayer, I. (2018): Assessment of Teams in a Digital Game Environment. *Simulation & Gaming*. doi:10.1177/1046878118770831

[40]. Mayer, I. – van Dierendonck, D. – van Ruijven, T. – Wenzler, I. (2014): Stealth Assessment of Teams in a Digital Game Environment. In: De Gloria, A, (eds) *Games and Learning Alliance. GALA 2013. Lecture Notes in Computer Science*. 8605. Springer, Cham. doi:10.1007/978-3-319-12157-4_18

[41]. March, J. G. (1986): Bounded Rationality, Ambiguity, and Engineering of Choice. In: J. Elster (ed.) *Rational Choice*. Oxford: Basil Blackwell, 142-170. (In: Farkas, 2006 im.)

[42]. Mérő L. (1996): Mindenki másképp egyforma. Tericum Kiadó, Budapest

[43]. Mérő L. (1998): The Prisoner's Dilemma. *Moral Calculations*. Springer, New York, NY, DOI:10.1007/978-1-4612-1654-4_3

[44]. Molnár S. – Szidarovszky F. (2011): Játékelmélet. Többcélú optimalizáció, konfliktuskezelés, differenciáljátékok. ComputerBooks, Budapest, 2011

[45]. Mook, D. G. (1987): Motivation. The Organization of Action. New York: W.W. Norton and Company, Inc. (In: Farkas, 2006 im.)

[46]. Musshoff, O. – Hirschauer, N. – Hengel, P. (2011): Are Business Management Games a Suitable Tool for Analyzing the Boundedly Rational Behavior of Economic Agents? *Modern Economy*. 2(4), 468-478. pp. doi:10.4236/me.2011.24052

[47].   Neuert, J. – Hoeckel, C. – Woschank, M. (2015): Measuring Rational Behavior and Efficiency in Management Decision Making Processes: Theoretical Framework, Model Development and Preliminary Experimental Foundations. *British Journal of Economics, Management & Trade*. 5(3), 299-318. pp., Article no. BJEMT.2015.025. doi:10.9734/BJEMT/2015/13486

[48].   Rapoport, Amnon – Seale, D. A. – Colman, A. M. (2015): Is Tit-for-Tat the Answer? On the Conclusions Drawn from Axelrod's Tournaments. *PLOS ONE* 10(7): e0134128. doi:10.1371/journal.pone.0134128

[49].   Rashid, A. – Cannon, H. M. – Morgan, F. W. (1988): A Model for Pricing Decisions in "First Period" Marketing Simulation Games. *Developments in Business Simulation & Experiential Exercises*. 15

[50].   Reeder, G. D. (2013): Attribution as a Gateway to Social Cognition. In: Carlston, D. E. (Ed): *The Oxford Handbook of Social Cognition*. Oxford University Press, 2013. doi:10.1093/oxfordhb/9780199730018.013.0006

[51].   Ruohomaki, V. (1995): Viewpoints on learning and education with simulation games. In J. O. Riis (Ed.) *Simulation games and learning in production management.* 14-28. pp. London, England: Chapman & Hall.

[52].   Schwab, K. – Samans, R. (2016): The Future of Jobs Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. In: *Global Challenge Insight Report (World Economic Forum)*. online elérhetőség: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf [letöltve: 2018-10-30]

[53].   Simon, H. A. (1947): Administrative Behavior. New York. Macmillan in: Jones, B. D. (2002): Bounded Rationality and Public Policy: Herbert A. Simon and the Decisional Foundation of Collective Choice. *Policy Sciences*. 35(3), 269-284. pp. online elérhetőség: https://www.jstor.org/stable/4532564

[54].   Simon, H. A. (1956): Rational Choice and the Structure of Environments. *Psychological Review*. 63(2), 129-138. pp. doi:org/10.1037/h0042769

[55].   Simon, H. A. (1991): Bounded Rationality and Organizational Learning. *Organization Science*. 2(1), 125-134. pp.

[56].   Szántó Z. (1998): A racionális döntések elméletén nyugvó társadalomtudomány. In: Csontos L. (vál.): *A racionális döntések elmélete*. Budapest: Osiris Kiadó, 7-24. pp. (In: Farkas, 2006 im.)

[57].   Teach, R. – Patel, V. (2007): Assessing Participant Learning in a Business Simulation. *Developments in Business Simulation and Experiential Learning*. 34

[58].   Tóth P. (2011): Tanulásmenedzsment és önszabályozó tanulás. *Óbuda University e-Bulletin*. 2(1), online elérhetőség: http://uni-obuda.hu/e-bulletin/Toth_2.pdf [letöltve: 2018-09-23]

[59].   Tversky, A. – Kahneman, D. (1974): Judgment under Uncertainty: Heuristics and Biases. *Science*. 185(4157), 1124-1131. pp. doi:10.1126/science.185.4157.1124 online elérhetőség: http://www.its.caltech.edu/~camerer/Ec101/JudgementUncertainty.pdf [letöltve: 2018-10-02]

[60].   Wellington, W. J. – Hutchinson, D. – Faria, A. J. (2010): The Impact of Playing a Marketing Simulation Game on Perceived Decision Making Ability among Introductory Marketing Students. *Developments in Business Simulations and Experiential Learning*. 37, 23-32. pp.

[61].   Wellington, W. J. – Hutchinson, D. B. – Faria, A. J. (2017): Measuring the Impact of a Marketing Simulation Game - Experience on Perceived Indecisiveness. *Simulation & Gaming*. 48(1), 56-80. pp. doi:10.1177/1046878116675103

[62].   Wolfe, J. (2016): Assuring Business School Learning With Games. *Simulation & Gaming*. 47(2), 206-227. pp. First published online: February 22, 2016; doi:10.1177/1046878116632872

[63].   Zsolnai L. (1998): Felelősség és döntés. Iskolakultúra. 1998/2, online elérhetőség: http://real.mtak.hu/61985/1/EPA00011_iskolakultura_1998_02_003-009.pdf

8 PUBLICATIONS IN RELATION WITH THE DISSERTATION

Scientific articles in English

Boda Márton Attila (2018): Avoiding Revenge Using Optimal Opponent Ranking Strategy in the Board Game Catan, International Journal of Gaming and Computer-Mediated Simulations (IJGCMS) Volume 10 (2), pp. 47-70 DOI: 10.4018/IJGCMS.2018040103

Boda Márton Attila, Ugrósdy György (2019): Enhancing Learning Outcome of Business Simulation Games via Process Feedback, Vadyba Journal of Management, 2019, Vol. 34 Issue 2, p73-78. 6p. ISSN 1648-7974

Scientific articles in Hungarian

Boda Márton Attila (2015): Bejelöltelek a Facebookon – közösségen kívüli közösséginek lenni, Studia Mundi – Economica, 2 (1). pp. 1-10. ISSN 2415-9395

Boda Márton Attila (2016): A döntések lélektanának bemutatása egy labdarúgó tippjáték példáján keresztül, Studia Mundi – Economica, 3 (2). pp. 26-44. ISSN 2415-9395

Boda Márton Attila (2017): Az alacsonynak tűnő kockázat elhanyagolása a sportfogadásokban, Studia Mundi – Economica, 4 (3). pp. 2-20. ISSN 2415-9395

Boda Márton Attila (2018): Nagy mennyiségű szakirodalom feldolgozásának támogatása egy tudományos folyóirat cikkeinek tartalom szerinti kategorizálásával szöveg-sűrűségi mutatók alapján a Simulation & Gaming tudományos folyóirat példáján, Studia Mundi – Economica, ISSN 2415-9395, Vol. 5 No. 4

Conference papers in English

Boda Márton Attila (2016): Improving Entrepreneurship in Secondary Education, International scientific conference Make it digital, Support for e-business in the V4 countries, Bratislava, Szlovákia, 2016. október 12. ISBN 978-80-223-4219-3

Boda Márton Attila (2016): The effect of former decisions on the later ones through a betting game, International scientific conference Make it digital, Support for e-business in the V4 countries, Bratislava, Szlovákia, 2016. október 12. ISBN 978-80-223-4219-3

Boda Márton Attila (2016): The experiences of courses with business simulation games and the further usability in developing business skills in startups, International scientific conference Make it digital, Support for e-business in the V4 countries, Bratislava, Szlovákia, 2016. október 12. ISBN 978-80-223-4219-3

Boda Márton Attila (2018): Current Usage Levels of Computer-Based Business Simulation Games in Academia Focusing Business Education of Hungary, International Conference on Business and Management Sciences: New Challenges in Theory and Practice 25th Anniversary of the Doctoral School of Management and Business Administration, Szent István University, Szent István Egyetem, Gödöllő, 2018. október 25-26. ISBN 978-963-269-831-1 DOI: 10.17626/dBEM.GSzDI25.P01.2018

Conference papers in Hungarian

Boda Márton Attila - Topa Zoltán (2013): A hazai banki szolgáltatásokhoz való hozzáférés összehasonlító elemzése településtípusonként, A hely szelleme – a területi fejlesztések lokális dimenziói, A Fiatal Regionalisták VIII. Konferenciáján elhangzott előadások, 2013. június 19-22.

Boda Márton Attila (2015): Üzleti szimulációs képzések tapasztalatai és további hasznosítási lehetőségei startupok esetében, Tudomány és innováció a lokális és globális fejlődésért Nemzetközi Tudományos Konferencia, Békéscsaba, 2015. november 19.

Abstract in conference proceedings in Hungarian

Boda Márton Attila (2017): Szemléletformálás új generációs üzleti szimulációkkal, Digitális Konferencia 2017. Digitális Tér, ELTE, 2017. november 18.