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# Evaluating the Educational Impact of the Game "Kietas riešutas": A Survey-Based Analysis

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**Abstract.** The integration of management education with information technology tools, such as simulation games and business analysis platforms, is playing an increasingly important role in developing students' decision-making skills as well as earn and acquire best business practices. It is particularly useful to test the didactic process effectiveness by the use of simulation game, i.e. to investigate the specificities of the use of the same software by teams from two countries. The analysis of the literature has shown that there are many cases where the same simulation tool is used by educationalists from different countries. The computer business game "Kietas riešutas" has been widely used in Lithuanian universities and colleges. The question naturally arises which aspects of the simulation game are perceived similarly by members of international teams and which are different. A questionnaire for students was developed for this purpose, on the basis of which the study was conducted. An additional questionnaire was used to investigate the relationship between the game and the uptake and usefulness of the game in computer science subjects for decision making. The paper compares the achievements obtained in the game, discusses the results of the simulation of international teams and the rationality of the decisions taken. The study showed that the business game not only helps to understand the purposeful use of information technology, but also motivates people to use it to achieve better game results.

**Keywords:** business games, K-Means, cross-cultural education, subjective evaluation, simulation games, k-means clustering, management decision-making.

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## 1. Introduction

A business game is an educational tool that models business operations in a competitive environment, effectively developing management and leadership skills through realistic process simulations. The first management simulation game, Top Management Decision Simulation, was developed in 1956 by the American Management Association (AMA) to increase understanding of decision making and improve analytical thinking among managers. Shortly afterwards, the University of California (UCLA) introduced the Executive Game, both of which relied on IBM 650 computers with decisions entered via punched cards, with simulations often lasting several hours.

The rapid development of computer technology in the 1970s led to a proliferation of business simulation games. By 1962, 89 different simulations had been identified and their use was expanding in universities and training institutions. In addition to computer-based models, tactile simulations such as board games also emerged. In particular, Gerhard Andlinger's 1958 simulation, published in the Harvard Business Review, illustrated business processes and financial results without computers and inspired countless variations.

A key innovation came from MIT's Sloan School of Management, where Jay Forrester pioneered the systems dynamics approach. This led to the MIT Beer Distribution Game, which modelled supply chain complexity in a board-based format, allowing participants to explore decision making and system responses under different scenarios.

It has become common practice in educational research to examine subjective evaluations of learning as a means of understanding the impact of pedagogical methods and tools. Such evaluations often capture students' perceptions of their own progress, focusing on areas such as analytical thinking, problem solving and application of knowledge. This approach reflects a growing recognition that learning outcomes are measured not only by objective assessments, but also through the lens of learners' experiences and self-perceptions. Scholars such as (Kolb, 1984) and (Schön, 2017) have emphasized the importance of experiential and reflective learning, which is closely aligned with this habit of gathering subjective feedback. By examining statements such as "I improved my analytical skills" or "It was a positive educational experience", researchers aim to uncover the nuanced ways in which individuals internalize and value their educational journeys. While inherently subjective, this practice provides valuable insights into the holistic impact of learning strategies.

Self-report measures are the chief problematic instruments in cross-cultural research with respect to measurement equivalence and, consequently, tend to compromise the validity of subjective data comparisons (He and van de Vijver, 2012). These inaccuracies have far-reaching consequences and misguide educational policies, organizations' strategies, and actual theoretical development (Avvisati *et al.*, 2019). This problem is found in the culturally-driven response styles such as tendencies toward socially desirable answers, acquiescence, or extreme responding; these can mask or mimic true differences between groups (Harzing *et al.*, 2012). Researchers attempt to solve this problem through measurement invariance, a proof statistical in nature that a tool works the same way everywhere (Stevanovic *et al.*, 2014). However, this has led to a spate

of debate among researchers insisting on strict application of statistical criteria against those calling for more practical, flexible approaches centered on external validity since full invariance is rarely achieved (Kusano *et al.*, 2025; van de Vijver, 2018). While the literature suggests better quality data, equal movement beyond culture-and context-agnostic translation is unarguably a better technique than simplistic techniques such as back-translation, which often lack empirical support (Angel, 2006). Instead, best practices are based on deep cultural adaptation via participatory research with interdisciplinary teams (Hunt, 2004) and use of innovative methods such as anchoring vignettes to reduce systematic bias (Krautz and Hoffmann, 2019). A methodological framework built on triangulation is, however, the most effective way forward. Such an approach brings the subjectivity of self-reports into a comparative clash or juxtaposition with concrete data sources to minimize the biases of any pure method (Fryer and Dinsmore, 2020). In this case, lectures should confirm students' self-representation against real data, which is standard to academic business games. Really, this combination approach is necessary to make sound conclusions about the evolution of skills and to prevent spurious cultural issues from propagating (Schaffer and Riordan, 2003).

The study of subjective evaluations in educational research is now a widespread practice, particularly in the context of understanding how students internalize their learning experiences. For example, a review by (Liu *et al.*, 2023) identified over 70 studies that used clustering techniques such as K-means to analyze educational data and subjective feedback, highlighting the growing use of data-driven methods in educational research. Similarly, (Tuyishimire *et al.*, 2022) note that the application of Business Games in higher education is steadily increasing, with their findings showing that 85% of recent studies in this area focus on identifying learning patterns, engagement and outcomes.

These figures reflect the extent to which subjective evaluations and advanced analytical techniques have become integral to contemporary educational research. Their prevalence underlines the growing recognition of the importance of learner-centred perspectives in assessing the effectiveness of pedagogical tools and methods.

One of business games is "Kietas riešutas" ("Hard Nut"), which has been used in several educational institutions in Lithuania (first of all, in Kaunas University of Technology, but also, for example, Vilnius University, Kaunas University of Applied Sciences) and Poland (in University of Lodz during Erasmus+ visits) (Pamula *et al.*, 2021). In it teams of students simulate enterprises producing two types of boilers. For each period, corresponding to a single financial year, they make decisions (the number of boilers to produce, the price, the number of workers to hire or fire etc.) and get the reports (Profit and Loss statement, Balance sheet etc.). They can also make non-final decisions to try out various strategies (as the decisions of competitors are unavailable in this case, it is assumed that all products will be sold successfully). Usually the game is played for 3–5 financial years. While business games are usually used for teaching subjects closely related to business, this game, having an open database, is also often used to teach subjects related to databases, promote computational thinking.

The aim of this study is to compare subjective evaluations of learning outcomes of students in Poland and Lithuania who have participated in business simulation games. Such a comparison seems to be especially fitting, given that the use of games in both

universities has already been compared (Pamula *et al.*, 2021). To analyze the collected data, the K-means clustering algorithm is used to identify patterns and group responses based on common characteristics. The following research questions were formulated:

- **RQ1:** How do students in Poland and Lithuania differ in their perceptions of the impact of business simulation games on their analytical thinking and problem solving skills?
- **RQ2:** To what extent do students from Poland and Lithuania value the application of prior knowledge in business games?
- **RQ3:** What similarities and differences exist in how students from both countries perceive business games as positive educational experiences?
- **RQ4:** How do cultural or educational system differences between Poland and Lithuania influence subjective evaluations of business games?
- **RQ5:** Can K-means clustering reveal distinct patterns or groupings in the subjective evaluations of students from Poland and Lithuania regarding their learning experiences with business simulations?

## 2. Literature Review on Subjective Evaluations in Educational Research

### 2.1. *Learning Outcomes for Business Games*

Business simulation games are presented in the literature as more effective in providing upskills and opportunities not only for evaluating results but also for providing feedback to players, designers and instructors conducting classes. The trend to use business games for teaching has been going on for years and the research conducted indicates the key impact of this method on the learning process (Ionescu-Feleagă *et al.*, 2025; Licorish *et al.*, 2018; Zulfiqar *et al.*, 2018), and acquiring good business practices (Peterková *et al.*, 2022).

The influence of games and simulations on the cognitive aspects of participants has been the subject of many individual studies and review papers (Fu *et al.*, 2016; Riemer and Schrader, 2015; Ferreira *et al.*, 2021; Fu *et al.*, 2022). Some of them are multidisciplinary study indicating the current stage in the applied areas Faisal *et al.* (2022) and some focusing on user experience analysis of business simulation games supported by human-computer interface based on data collection techniques with Electroencephalogram or Eye tracking signals (Ferreira *et al.*, 2024, 2021).

More than 40 years ago Kolb (1984) argued that learning should be seen as a process rather than a set of outcomes. To tackle this issue, 2 years later Adelman (1986) proposes that instead of attempting to evaluate what participants have learned and how they have changed, it is more effective to ask them what they gained from the learning experience. In his 3P -three-stage model, Biggs (1985) describes student learning as a process including presage, process, and product. These three elements correspond to the learning environment and the characteristics of students, the learning methods, and the results of learning, respectively. Xu and Yang (2010) proved that social interaction and

psychological safety had a positive impact on knowledge acquisition while playing business games. The learning experience refers to students' experiences of courses, activities, instructional interactions, and the learning environment during the learning process. The conceptual framework of experiential learning underscores the flow characteristics of educational results and posits that, during the recursive cycle of experiential learning, certain outcomes possess the potential to affect the attainment of alternative outcomes (Kolb, 1984; Ranch-hod *et al.*, 2014). The most applied representation of the experiential learning process is the Lewinian model (Kolb, 1984; Kolb and Kolb, 2012).

The basic classification of learning outcomes in games and simulations described in the literature is mainly following Bloom's taxonomy (Bloom *et al.*, 1956) distinguishes three categories, namely: cognitive, behavioral and affective outcomes (Anderson and Lawton, 2009; Garris *et al.*, 2002; Salas *et al.*, 2009; Vlachopoulos and Makri, 2017).

Some more detailed classification is proposed by other authors. Conducting the study on current literature on relationship between learning experience and academic engagement Liu *et al.* (2023) identified three main dimensions (activity, perception, and attitudes and behaviors) and eleven corresponding sub-dimensions (interaction, collaboration, technical and pedagogical aspects, relationship to knowledge, to competency, to learning, self-efficacy, satisfaction, motivation, and engagement).

Simulations are usually closely connected to the course material, providing students with the chance to apply and deepen their understanding of theoretical concepts. Cognitive outcomes are achieved through simulations, which are designed to enhance various cognitive skills, including deep learning, critical thinking, scientific reasoning, action-based learning, transformative learning, decision-making, knowledge acquisition, content comprehension, and problem-solving (Fu *et al.*, 2016; Ranchhod *et al.*, 2014; Towler *et al.*, 2009; Vlachopoulos and Makri, 2017). Researchers mainly point to a high level of cognitive development, development of critical thinking and strengthening of motivation (All *et al.*, 2014). Lee *et al.* (2022) examined how relative performance feedback (RPF) in simulation games influences students' learning and outcome performance. Buil *et al.* (2018) investigated also the role of flow experienced while using business simulation games, including the influence of challenge, skill, feedback and goal clarity on students' experience of flow as well as the influence of flow on the development of general skills, perceived learning and satisfaction. Students perceive games as good tools for learning through experience, at the same time providing pleasure from participating in classes (Andreu-Andrés and García-Casas, 2011). On the other side literature also indicates that the use of games in the field of cognitive perception can yield mixed results. For example, Riemer and Schrader (2015) showed that simulations support understanding and application of knowledge in some cases, although they are less effective than quizzes and adventures. Fu *et al.* (2016) pointed out that although games provide a motivating and enjoyable experience, there is still a lack of strong evidence that games lead to effective learning outcomes.

The behavioral outcomes for college students described in the literature include enhanced teamwork and interpersonal skills (Ranchhod *et al.*, 2014), along with improved organizational abilities, adaptability, and conflict resolution skills (Vos and Brennan, 2010).

The business games necessarily try to achieve learning objectives of various levels, especially when they are used by students whose familiarity with business varies greatly. For example, students of Faculty of Informatics have studied little Economics or Accounting, thus the game can provide an opportunity to achieve learning objectives of Knowledge level of Bloom's taxonomy in areas related to basic financial reports, while for the students who have studied more Business and Economics, the business game (especially with making a report) can provide an opportunity to achieve learning objectives of higher levels.

That is an additional challenge in evaluation of business games, as evaluating achievement of each objective separately would require a great number of research questions. This makes it inconvenient to use grades for such an evaluation. Because of that, we have chosen to use a survey with relatively wide questions and the results of the game itself.

### 2.2. *Data Collection*

Students' opinions and perception remain as most cases the subject of analysis and data are mainly gathered via the survey method (Fu *et al.*, 2022). As an example, the study by (Wong *et al.*, 2022) investigated students' perceptions and satisfaction of how simulation games impact learning performance in higher education. Such an assessment has some limitations as without evaluating how effective the application was in enhancing students' knowledge and performance can present only partial effectiveness. Studies aimed at determining what students learn from simulations have primarily relied on perceptions of learning, rather than more objective standards, which has been a significant limitation highlighted by researchers over the years (Anderson and Lawton, 2009, 1992). While the literature shows attempts at objective assessments (Anderson and Lawton, 1992), these have mainly focused on the lower levels of Bloom's taxonomy of cognitive learning. In some cases, measuring perceptions is a valid approach, and in others, assessing the lower levels of Bloom's taxonomy is suitable. However, it is important to clearly distinguish between these cases. As (Anderson and Lawton, 2009) point out, when evaluating the effectiveness of a pedagogical tool in improving attitudes toward learning in a course or discipline, measuring student perceptions is appropriate, as there are limited alternatives. However, when assessing aspects of learning such as vocabulary knowledge, rule understanding, or the ability to apply rules, measuring perceptions may not be effective. In such cases, measuring at the lower levels of Bloom's taxonomy is more appropriate if the goal is to determine whether students possess basic knowledge or understanding, such as of the business environment (Vlachopoulos and Makri, 2017).

Observing how students interact with the game and each other during gameplay can provide additional context for understanding their learning experiences. Online data collection is employed to minimize intrusion into game activities. In some cases, the data collected is a combination of screen activity synchronized with audio of player discussion. Wideman *et al.* (2007) contend that these recordings, combined with questionnaires, can make detecting unexpected processes and problems much easier. Buil *et al.* (2018) used a mixed method to assess the learning outcomes of warnings by observing

students while making decisions while participating in business simulation games and using a survey method to assess their results. As a mixed method behavioral observations during the simulation can complement methods based on perceptions. The effectiveness of the business game and the potential they offer are subject to various types of new measurements combined with IT technologies. This approach requires a new model centered on students' learning experience (de Freitas and Maharg, 2011). Newest models apply more neuroscience into the development and measurement process. In those solutions an analysis of information from physiological measurement devices that analyze the user's experience in an integrated way and can contribute to their design development and effectiveness is performed (Ferreira *et al.*, 2021).

### 2.3. *Methods of Analysis*

Different techniques are applied and described to collect, measure and analyze learner performance and evaluate the results. Researchers use quantitative or qualitative methods, many of them use mixed methods. Various types of data from different sources are analyzed. Surveys are one of the most common tools for gathering perceptions from students (Fu *et al.*, 2022; Xu and Yang, 2010; Vlachopoulos and Makri, 2017). (Zulfiqar *et al.*, 2018) applied Technology Adoption Model (TAM) to create constructs and develop questionnaires. Examples of developed validated and discussed questionnaires (Brühlmann and Schmid, 2015; Law *et al.*, 2018; Safiena and Goh, 2024) show the basic construct examined. Those tools often apply 5 or 7 points Likert-scale questions, open-ended questions, and self-assessment items that allow students to express how they feel the simulation has impacted their learning outcomes (Lee *et al.*, 2022; Towler *et al.*, 2009; Wong *et al.*, 2022; Hernández-Lara *et al.*, 2019).

In their wide analysis of games and simulations in higher education, (Vlachopoulos and Makri, 2017) found out that most researchers use either experimental or quasi-experimental designs, typically involving pre-test and/or post-test evaluations, to assess outcomes. The impact of games and simulations on learning outcomes is measured by comparing the differences between pre-test and post-test scores in these designs. Specifically, researchers analyze the score improvements in both control and experimental groups to assess the effectiveness of the games and simulations being tested. In the papers they reviewed, the researchers found that the majority of studies use quantitative methods for evaluation, with qualitative methods being less common, and mixed research methods being employed to offer practical insights and ensure methodological triangulation of results.

Quantitative studies typically utilize tools such as knowledge questionnaires, academic assessments, and cognitive tests, while qualitative studies rely on methods like interviews, case studies, observations, and focus groups. The studies also vary in the duration of game-play and methods of interaction, ranging from a single session to extended periods of play, with sustained engagement lasting several weeks or even months. Researchers use other tools of the survey method that allow for a deeper and more precise analysis of perceptions. These are semi-structured or structured interviews that al-

low for asking follow-up questions that can explore their thoughts and reflections more deeply (Safiena and Goh, 2024). Garris *et al.* (2002) analyzed open-ended responses from students who participated in a business simulation. They used content analysis to identify recurring themes regarding students' perceived improvement in areas like strategic thinking, decision-making, and teamwork. To extend qualitative studies focus groups are used as source of data for analysis. Especially the comments of participants discussing their experiences and observations on available electronic forums (Hernández-Lara *et al.*, 2019; Tan *et al.*, 2023). This method allows for a dynamic exchange of ideas in which students can jointly reflect on the simulation and present observations on their learning outcomes (Anderson and Lawton, 1992). Self-assessment tools and reflective journals with students' evaluations of their own learning experiences during or after playing a business simulation are also qualitative methods used in research. These tools help capture the subjective learning outcomes that may not be easily measured by traditional tests or assessments. The results of students' journal analysis on reflection during a business simulation and learning outcomes are seen as valuable resources (Hernández-Lara *et al.*, 2019).

Different methods are applied to explore the data and test the hypothesis. Frequently used methods presented in the literature are descriptive statistics including principal component analysis (PCA) (Peterková *et al.*, 2022; Towler *et al.*, 2009; Xu and Yang, 2010; Obi *et al.*, 2021), structural equation modeling (SEM) (Hair *et al.*, 1998; Kline, 2015), envelopment analysis (DEA) (Shero *et al.*, 2021). SEM has become one of the important techniques for researchers across disciplines, and social sciences researchers are also adopting these methods to validate their research results (Zulfiqar *et al.*, 2018; Hooper *et al.*, 2007). (Buil *et al.*, 2018) applied partial least squares (PLS), a variance-based structural equation technique. The same method was used by (Adib, 2024) to assess the role of business simulations in shaping student attitudes towards sustainability. Applying the DEA method to business simulation games expands its area of application to cover the learning evaluation assessment of students in higher education, or teams undergoing business simulation training. (Koltai and Tamás, 2022) applied input-oriented constant return-to-scale DEA models for evaluating the performance of teams participating in business simulation games and showed how DEA results can be incorporated into performance grading.

## 3. Methodology

### 3.1. *Analysis of Survey Responses Using K-Means*

Students from Kaunas University of Technology (KTU) in Lithuania and the University of Lodz (UL) in Poland participated in the first survey (see Table 2 for the list of questions). The survey was based on the surveys used previous work (Pamula *et al.*, 2021).

By applying K-Means clustering, this study aims to uncover latent structures within the data and provide a nuanced understanding of the similarities and differences in the subjective evaluations of students from the two countries.

K-means clustering is a partitioning algorithm that groups data points into clusters based on similarity, typically measured by Euclidean distance. It assumes that clusters are approximately spherical in shape, have similar variance and are distinct from each other. Despite these assumptions, K-means has proven robust and effective in educational contexts, particularly for analysing subjective rating data where perfect cluster shapes may not occur.

Our study builds on previous research that has used K-means clustering to analyse educational data and identify meaningful patterns in student learning and assessment. For example, the study (Liu, 2022) demonstrates the application of clustering techniques to uncover insights into student evaluations. Similarly, research (Tuyishimire *et al.*, 2022) illustrates the effectiveness of K-Means clustering in identifying patterns of learning behaviour and engagement in higher education contexts.

Following the methodology of these studies, our research applies K-means clustering to compare subjective ratings of students in Poland and Lithuania. This approach seeks to identify patterns and differences in their perceptions of business games as educational tools, providing insights into how cultural and educational contexts shape students' learning experiences.

We applied the K-means clustering algorithm to student responses to 11 Likert-scale survey items, each using a 5-point scale ranging from strong disagreement (1) to strong agreement (5). These items assessed students' perceptions of the educational impact of the Kietas riešutas business simulation game. They spanned thematic areas such as foundational business knowledge, financial literacy, information technology, engagement, and data analytics. The selected items were theoretically grounded and aligned with core learning outcomes in business education, combining both traditional and contemporary skill domains.

Table 1 details the survey items incorporated into the clustering analysis, along with their corresponding conceptual dimensions. The item labels correspond to questions from Table 2.

Table 1

Survey Items Used in K-means Clustering

| ID, I | ID, II | Dimension |
|---|---|---|
| Q1.1 | K6 | Business Understanding |
| Q1.2 | K7 | Financial Literacy |
| Q1.3 | K8 | Tech Literacy |
| Q1.4 | K9 | Decision-Making |
| Q1.5 | K10 | Marketing Knowledge |
| Q1.6 | K11 | Engagement |
| Q1.7 | K12 | Applied IT Skills |
| Q1.8 | K13 | Data Literacy |
| Q1.9 | K14 | Accounting Literacy |
| Q1.10 | K15 | Systems Thinking |
| Q1.11 | K16 | Data-Informed Decision-Making |

We did not standardize or normalize the Likert-scale survey items before clustering, because all variables used the same 1–5 response scale and showed similar levels of variance. This consistency reduced the risk of bias from scale differences. Still, future research may apply standardization to test the robustness of the clustering results.

### 3.2. *Analysis of Results of the Game*

In addition to analysing subjective survey responses, it is important to examine the objective results achieved by students during the business simulation. This dual perspective allows for a more comprehensive understanding of learning outcomes. Performance indicators such as net profit, sales, advertising expenses and marketing effectiveness were analysed across different universities and faculties using data collected from the business game 'Kietas riešutas'.

In evaluating a business game is important to explore not just the students' perceptions of the game, but also the results they achieve in making decisions. The database collected during the game was used to analyse the results and was also used by the students to explain the results and make informed decisions.

In Kaunas University of Technology (KTU) the business game was used in modules "Simulations of Strategic Business Processes" and "Performance Analytics and Data Mining". These modules are taken by students of various faculties: Informatics, Economics and Management, Natural Sciences and Mathematics. The business game is introduced in one lecture (1.5 hours). Next week, in class, two financial years are played (also, the first attempt is taken back). Then the students make decisions of three remaining years at home (with a week given for each financial year). Then the students learn to analyse the data they collect with MS Excel, MS Access and MS Power BI.

In University of Lodz (UL), the business game was introduced and played in a single class (a bit longer than a regular one). Three financial years were played, with the first attempt taken back.

### 3.3. *Analysis of Responses of Second Survey*

To complement the first survey, a second survey was conducted with KTU students, focusing specifically on the use of IT tools during the simulation. This allowed for a more detailed evaluation of how technological support influenced the decision-making process. The survey questions are listed in Table 2. There were also several open questions.

This survey was used in two main ways. First, its results were compared with the results of the previous survey to see if the results are comparable, and if the survey can be expected to be statistically valid. Then the additional questions concerning use of tools (Q15.1 to Q15.4) were analysed. Also, Cronbach's alpha was calculated (0.907), suggesting that the questionnaire was statistically valid.

Table 2

Survey Questions Evaluating the Educational Impact of the Business Game "Kietas Rie utas" in first and second surveys

| ID, I | ID, II | Question |
|---|---|---|
| Q7 | K1 | Which faculty do you study in? |
| Q2 | K2 | How successfully did you work in a team? (ignoring the place) |
| Q6 | K3 | Have you played computer business games before? |
| Q5 | K4 | Was the game's introduction in a lecture sufficient? |
| Q3 | K5 | Did you have enough time to make decisions? |
| Q4 | K5.1 | Did the work in a team help you to get acquainted with other students? |
| Q1.1 | K6 | The Business Game (BG) "Kietas rie utas" provides participants with knowledge about the company's activities. |
| Q1.2 | K7 | The Business Game "Kietas rie utas" gives players a basic understanding of finance. |
| Q1.3 | K8 | The Business Game "Kietas rie utas" provides participants with knowledge on the applicability of information technologies in business. |
| Q1.4 | K9 | The Business Game "Kietas rie utas" provides participants with knowledge on decision-making. |
| Q1.5 | K10 | The Business Game "Kietas rie utas" provides participants with knowledge about the company's marketing activities. |
| Q1.6 | K11 | Using the game made the activities more interesting than traditional ones. |
| Q1.7 | K12 | The game helped to improve the understanding of the applicability of DB in business, to test software tools for working with business DB and to clarify the potential applicability. |
| Q1.8 | K13 | BG has helped me to understand the place and benefits of business data analytics for the business better, to understand where and how MS Power BI can be applied to achieve better results for the company better. |
| Q1.9 | K14 | The business game helped to get an idea and understanding of the typical accounts: the "Balance Sheet", the "Profit/Loss" and others. |
| Q1.10 | K15 | The Business Game has helped to improve the understanding of the dependence of some business indicators on others. |
| Q1.11 | K16 | BG has helped understand the needs of the enterprise with data analytics, how it can help business decision-making. |
| Q10 | - | BG has helped understand the ways in which business simulations are made. |
| Q11 | - | Were the data in the reports shown in the game sufficient for making good decisions? |
| Q12 | - | Were the data in the reports made during the lectures using BI sufficient for making good decisions? |
| Q13 | - | Would the data in the reports that could be made using BI (if more time was available) have been sufficient for making good decisions? |
| Q15.1 | - | Which of those tools would be useful for making the decisions? [MS Access] |
| Q15.2 | - | Which of those tools would be useful for making the decisions? [MS Excel] |
| Q15.3 | - | Which of those tools would be useful for making the decisions? [MS Power BI] |
| Q15.4 | - | Which of those tools would be useful for making the decisions? [ChatGPT or other generative AI] |

## 4. Results

### 4.1. *Analysis of Survey Responses to the Business Game 'Kietas riešutas'*

The survey aimed to assess participants' perceptions and learning outcomes from engaging with the Business Game (BG) "Kietas riešutas". Each question addressed specific competencies or areas of understanding expected to be enhanced through participation in the game. Responses were distributed on a five-point Likert scale, where 1 represented "strongly disagree" and 5 represented "strongly agree". The histograms visualizing the distribution of responses to each question reveal several key insights:

A majority of the questions (e.g., K6, K7, K8, K10) exhibit a notable skew toward higher ratings (4 or 5). This trend indicates that participants generally agree or strongly agree that the game positively influenced their understanding of key business concepts, such as decision-making, finance, and the applicability of information technologies in business.

Certain questions, particularly K9 and K11, appear to show slightly more variation in responses, suggesting that while most participants appreciated the knowledge gained in areas like financial understanding and data analytics, a minority may have found these aspects less impactful or relevant.

The uniformity of high ratings across all questions underscores the game's comprehensive approach to business education. Domains such as marketing (K5), decision-making (K4), and the application of MS Power BI for business analytics (K8) received robust positive feedback, affirming the utility of the game as an interdisciplinary tool.

K6 highlights an important observation – participants largely agree that using the game was more engaging than traditional teaching methods. This points to the potential for gamified learning to enhance interest and participation in educational settings.

While the overall results are encouraging, the presence of lower ratings in some responses, although minimal, may indicate areas for refinement. For example, ensuring the game is universally accessible and relevant across all participant backgrounds could help improve its perceived efficacy in areas like finance (K9) and data analytics (K11).

The findings affirm the Business Game's role in fostering knowledge and engagement in business-related disciplines. The high levels of agreement suggest that participants recognized the game's value in both theoretical and practical dimensions of business education. However, minor variances in responses highlight the importance of continuous feedback to enhance the game's inclusivity and effectiveness across all domains. Future research could delve deeper into the reasons behind these variances and explore the long-term impacts of gamified learning on professional competencies.

The survey questions presented in Table 1 aim to assess the educational impact of the business game (BG) "Kietas riešutas" in promoting participants' understanding of various business-related areas. These questions focus on key learning outcomes, including knowledge acquisition about business activities (K6), finance (K7), information technol-

ogy (K8), decision-making (K9) and marketing (K10). In addition, the survey explores participants' perceptions of the game's ability to increase engagement compared to traditional methods (K11) and its role in improving understanding of complex concepts such as database applications (K12), business data analysis (K13), financial reporting (K14), interdependencies of business indicators (K15), and business needs (K16).

To ensure a comprehensive understanding of the educational effectiveness of the simulation, the following analysis examines the distribution of responses across faculties and clusters. As well as identifying trends and areas of strength, the analysis highlights the proportion of participants from different faculties whose responses aligned with particular learning outcomes. By rescaling the results to account for the volume of responses from different faculties, we aim to provide a balanced and nuanced interpretation of the data, ensuring that the findings reflect both the scale and relative impact of the game's contributions.

This analysis serves to underscore the value of "Kietas riešutas" as a gamified learning tool, while identifying potential areas for refinement to ensure its continued relevance and effectiveness in business education.

The bar chart in Fig. 1 illustrates the distribution of survey responses across four faculties: UL_M, IF, EVF and MGMF. Among these, the EVF faculty has the highest participation, with more than 40 responses, indicating a significant representation in the survey results. Conversely, the UL_M faculty has the lowest number of responses, with less than 20 participants. The IF faculty follows as the second highest contributor with around 30 responses, while the MGMF faculty is similarly represented but slightly lower than the IF.

The disparity in the number of responses suggests that the EVF faculty may have a greater impact on the overall results of the survey. This imbalance highlights the need to consider relative contributions in the analysis to ensure that the findings reflect proportional representation rather than being skewed by over-represented groups. In addition, the lower response rates from faculties such as UL_M and MGMF highlight potential areas for improved engagement in future surveys or studies to ensure a more balanced and inclusive dataset.

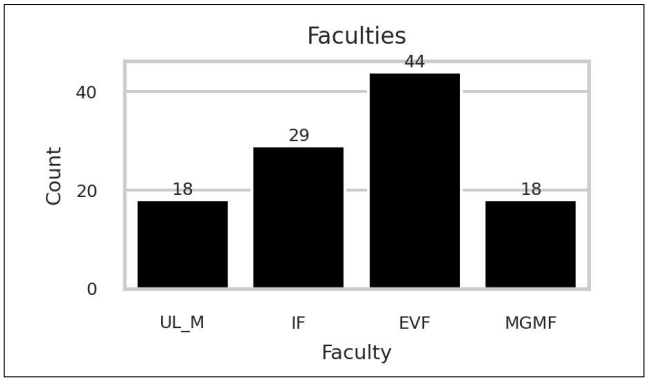



Fig. 1. Numbers of students from various faculties in the first survey.

This distribution will be carefully considered in subsequent analysis to ensure that results are normalised and fair comparisons are made between faculties.

The heatmap in Fig. 2 illustrates the correlation coefficients between different survey items (K6 to K16), providing insights into the relationships between participants' responses. The correlation values range from 0.3 to 1, where darker shades indicate stronger positive correlations and lighter shades represent weaker relationships.

The structure of the clusters, when aligned with the survey questions, reveals distinct thematic focuses that reflect notable patterns in participants' responses. Cluster 0 appears to prioritise basic business knowledge, with responses strongly linked to questions such as K1[SQ001], which assesses knowledge of business activities, K1[SQ002], which assesses a basic understanding of finance, and K1[SQ005], which relates to marketing activities. This suggests that Cluster 0 is characterised by participants who value the game for its ability to provide a solid grounding in tradition-al business areas.

In contrast, Cluster 1 is closely associated with questions that emphasise advanced and innovative aspects of the game. Responses in this cluster are associated with items such as K1[SQ003], which highlights the applicability of information technology in business, K1[SQ007], which explores database applications, and K1[SQ008], which focuses on business data analysis and tools such as MS Power BI. This suggests that Cluster 1 represents participants who value the game for its ability to introduce cutting-edge tools and analytics-driven decision-making processes.

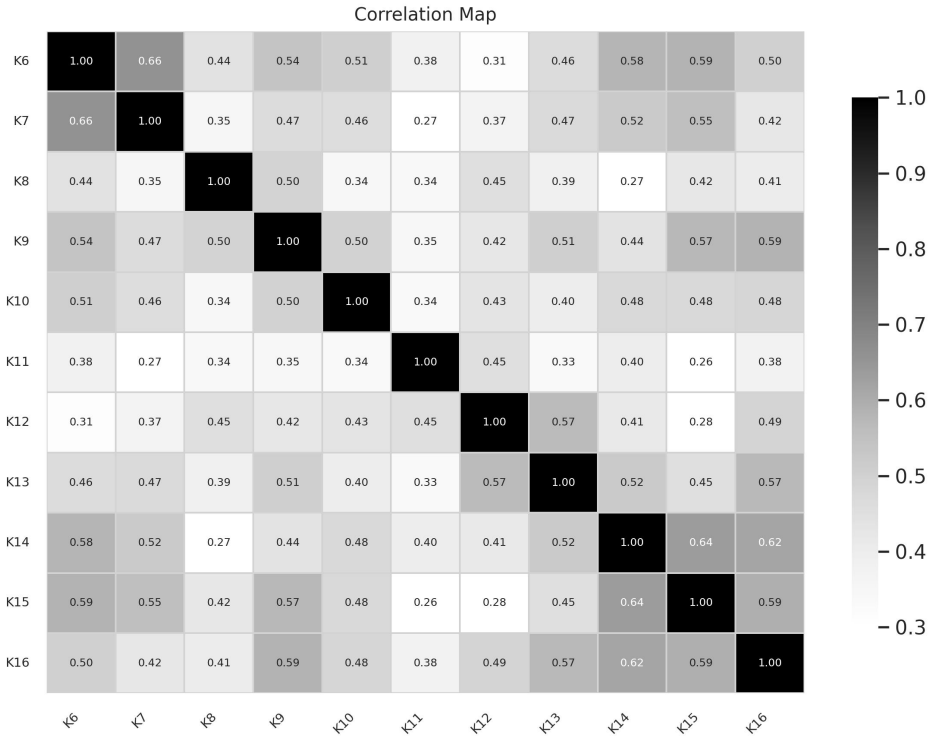



Fig. 2. Correlation map of the first survey.

Comparing the clusters highlights a thematic divide. Cluster 0 focuses primarily on traditional business principles, providing an effective platform for basic learning. Conversely, Cluster 1 reflects an engagement with more advanced topics such as technology integration and data-driven insights. These patterns underline the versatility of the business game "Kietas riešutas", which appeals to a diverse participant base with different educational priorities and interests.The heatmap reveals a general trend of positive relationships between the items, though the strength of these relationships varies. The strongest connections are observed within closely related areas, reflecting consistency in participant responses to conceptually similar constructs. These patterns provide valuable insights into the internal consistency and multidimensional nature of the survey, paving the way for further thematic analysis to identify underlying factors or domains of interest.

The bar charts in Fig. 3 present the distribution of responses for survey items K6 through K16, rated on a 5-point Likert scale (1 – strongly disagree to 5 – strongly agree).

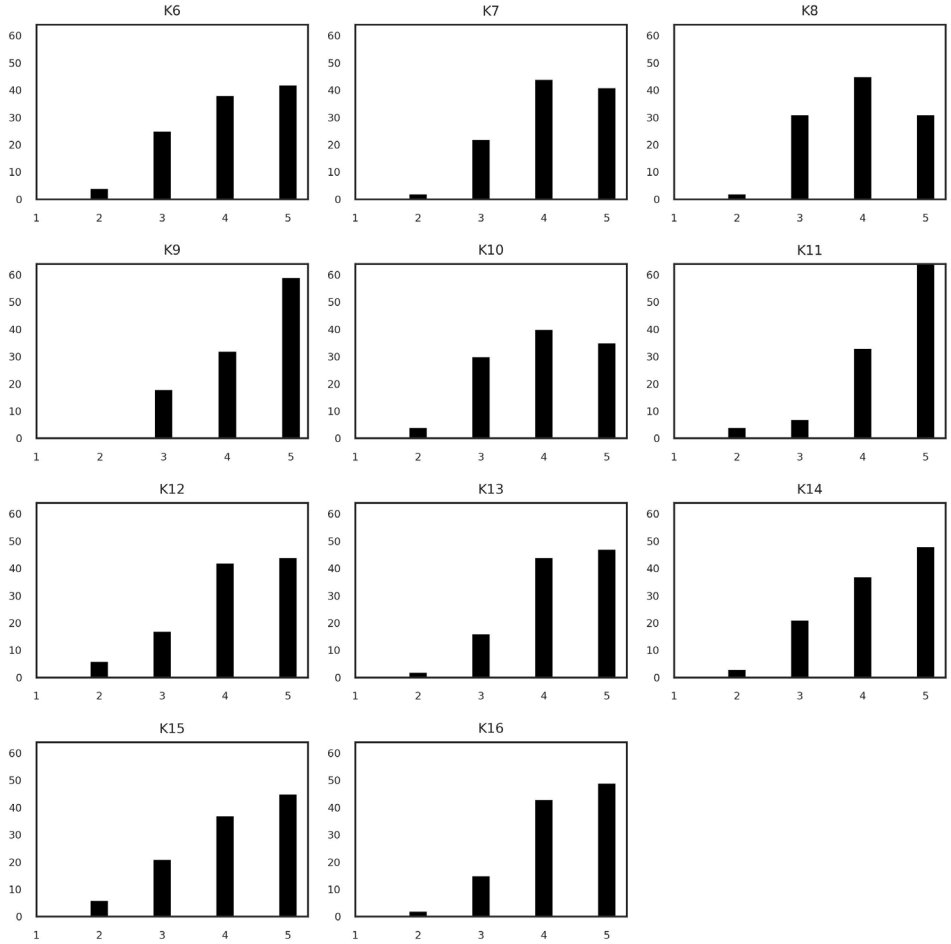



Fig. 3. Bar charts for different questions in the first survey.

Across the items, the distributions reveal consistent trends, indicating participants' positive reception of the Business Game (BG) "Kietas riešutas".

The analysis of the survey responses reveals remarkable patterns in the participants' feedback on the business game "Kietas riešutas". A clear dominance of high ratings is observed in most items, with a significant concentration of responses in levels 4 and 5. Questions such as K6, K7 and K8 show particularly strong agreement, indicating that participants found the game engaging and effective in improving their understanding of key business concepts such as decision-making and the applicability of information technologies.

While high ratings are widespread, certain items such as K12 and K13 show greater variability, with a notable proportion of responses at level 3. This suggests that these aspects of the game, which are likely to relate to specific or technical areas of knowledge, were perceived as less universally applicable. In addition, there are some outliers with lower scores in items such as K10 and K11, which show small but consistent responses at levels 2 and 3. These results highlight potential areas for improvement, particularly in teaching concepts related to interdependencies between business indicators or advanced data analysis.

Despite these variations, the overall trend of strong agreement reinforces the effectiveness of the game as a learning tool. Items such as K15 and K16 receive remarkably high levels of agreement, underlining the perceived success of the game in fostering an understanding of financial interdependencies and decision-making processes. These findings confirm the educational value of the game, while providing insights into areas that could benefit from refinement to enhance its overall impact. The distribution of responses underscores the game's educational impact, with most participants agreeing or strongly agreeing with the statements. However, the observed variability in certain items suggests potential areas for refinement to ensure all aspects of the game deliver uniformly high value. Further analysis could explore the factors contributing to these variations to enhance the game's effectiveness.

The graph in Fig. 4 shows the application of the elbow method to determine the optimal number of clusters (k) for k-means clustering, using the cost function (sum of squared distances, SSD) as the evaluation metric. The cost decreases as k increases, reflecting the improved compactness of clusters with higher cluster counts.

The cost decreases significantly from $k = 2$ to $k = 3$, indicating that increasing the number of clusters initially leads to significant improvements in cluster quality.

Beyond $k = 3$, the rate of cost reduction begins to decline, suggesting diminishing returns with additional clusters. The elbow point, where the curve begins to flatten, appears around $k = 2$. This suggests that tho clusters strikes a balance between minimising cost and avoiding unnecessary complexity.

While the cost continues to decrease for $k = 4$, $k = 5$, and $k = 6$, the incremental improvement becomes minimal. This indicates that additional clusters may not add significant value and may result in overfitting or loss of interpretability.

Based on the elbow method, $k = 2$ appears to be the optimal number of clusters for this dataset. This result is consistent with the principle of achieving simplicity and efficiency in clustering while maintaining meaningful distinctions between groups. Further

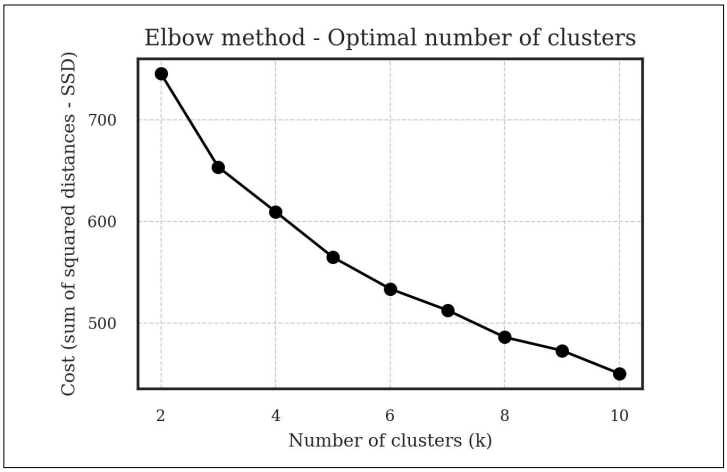



Fig. 4. Graph illustrating the application of Elbow method.

analysis can validate this choice by examining the characteristics and interpretability of the resulting clusters.

The silhouette score of 0.494 provides an assessment of the clustering quality achieved by the k-means algorithm. This score, which ranges from −1 to 1, measures how well the clusters are separated and how tightly the data points are grouped within their assigned clusters.

A score of 0.494 indicates moderate clustering quality. The clusters are somewhat distinct, but there is room for improvement in either the separation between clusters or the cohesion within clusters.

The score indicates that many data points are reasonably close to their cluster centroids and far from the centroids of other clusters. However, there may be overlap or ambiguity for certain points that could belong to multiple clusters.

The moderate score is consistent with the findings of the elbow method, where $k = 2$ appeared to be an optimal choice. However, further refinements, such as adjusting the number of clusters or exploring advanced clustering methods, may help to improve the silhouette score and enhance clustering quality.

While the silhouette score of 0.494 indicates that the clustering is reasonably effective, it also highlights potential areas for improvement. This score provides a basis for interpreting the clusters, but suggests that further fine-tuning or validation of the cluster structure may be beneficial to ensure robust and meaningful groupings.

Moreover, the two-cluster solution aligns with the theoretical aim of identifying broad learner profiles. One group exhibited stronger engagement and perceived value from the simulation, while the other showed more critical or less involved responses. This interpretability reinforces the practical relevance of choosing $k = 2$ despite the moderate silhouette score.

We conducted Kruskal-Wallis H tests on all 11 Likert-scale variables to determine whether the identified clusters differ significantly in their evaluation of the game. As shown in Table 3, the results reveal statistically significant differences across all items (with p-

Table 3
Kruskal-Wallis H-Test Results Comparing Clusters on Survey Items

| Dimension | H-statistic | p-value |
|---|---|---|
| Business Understanding | 46.798 | $7.87 \times 10^{-12}$ |
| Financial Literacy | 45.056 | $1.91 \times 10^{-11}$ |
| Tech Literacy | 28.234 | $1.08 \times 10^{-7}$ |
| Decision-Making | 47.562 | $5.33 \times 10^{-12}$ |
| Marketing Knowledge | 41.590 | $1.13 \times 10^{-10}$ |
| Engagement | 32.036 | $1.51 \times 10^{-8}$ |
| Applied IT Skills | 31.358 | $2.15 \times 10^{-8}$ |
| Data Literacy | 41.964 | $9.30 \times 10^{-11}$ |
| Accounting Literacy | 50.953 | $9.46 \times 10^{-13}$ |
| Systems Thinking | 48.818 | $2.81 \times 10^{-12}$ |
| Data-Informed Decision-Making | 57.455 | $3.46 \times 10^{-14}$ |

values below 0.001 in most cases), indicating that the clusters represent distinct groups of learners who evaluated the simulation experience in meaningfully different ways.

These variables cover a range of educational dimensions, including business knowledge, decision-making, data literacy, and IT application. The strong statistical separation reinforces the interpretability of the clusters and supports the validity of the segmentation based on survey responses.

The scatter plot in Fig. 5 visualises the clustering results after dimensionality reduction using Principal Component Analysis (PCA). The data, originally in higher dimensional space, has been projected onto two principal components (PCA Component 1

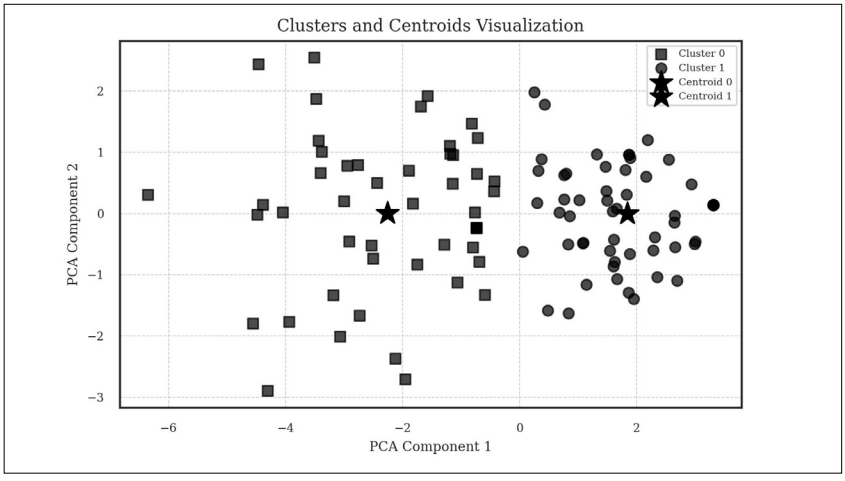



Fig. 5. Scatter plot illustrating the clustering using K-Means (Cluster 0 grouping the students that more positively responded to questions about basic business knowledge, Cluster 1 grouping students who responded more positively to questions related to technology and data use).

and PCA Component 2) for improved interpretability. The plot effectively shows the clusters and their corresponding centroids.

The plot shows two distinct clusters, Cluster 0 (squares) and Cluster 1 (circles), with a noticeable separation between them in the reduced dimensional space. This indicates that the k-means algorithm has successfully grouped the data into distinct clusters.

The centroids of the clusters are marked with black stars, Centroid 0 and Centroid 1, located near the centre of their respective clusters. These centroids represent the average position of the data points in each cluster and provide a clear reference point for understanding the central tendencies of the groups.

Cluster 1 appears to have tighter cohesion, with most points concentrated near the centroid. In contrast, Cluster 0 has a wider dispersion, suggesting that the data points in this cluster may be more dispersed or heterogeneous.

While PCA captures most of the variance in the data, it is important to note that some information from higher dimensions may be lost. The visualised separation should therefore be interpreted as a simplified representation of the true clustering structure.

The PCA-based visualisation effectively highlights the clustering structure, showing clear separation and cohesion within the identified clusters. The relative proximity of the centroids and the spread of the points provide valuable insights into the characteristics of each cluster. Further analysis may involve examining the original feature space to gain a more detailed understanding of the differences between these clusters.

The Kruskal-Wallis test results reinforce the robustness of the identified cluster structure. Clusters differed significantly on all survey items used in clustering, covering dimensions such as Business Understanding (Q1.1 / K6), Decision-Making (Q1.4 / K9), Engagement (Q1.6 / K11), and Data-Informed Decision-Making (Q1.11 / K16). The differences between clusters were most evident in items related to data literacy, accounting literacy, and systems thinking. These areas show that students engaged with and applied the simulation differently, supporting the cluster distinction and highlighting differences in how they learned and behaved.

The content of the identified clusters can be understood by examining their alignment with specific survey questions, reflecting distinct thematic focuses among participant responses.

Cluster 0 centers on responses that emphasize basic business knowledge. Students in this group gave higher ratings to items about understanding company operations (Q1.1 / K6), finance (Q1.2 / K7), and marketing (Q1.5 / K10). This suggests they saw the simulation as a way to reinforce traditional business foundations.

Cluster 1, by contrast, groups students who responded more favorably to questions related to technology and data use. They rated items like the application of IT (Q1.3 / K8), use of databases (Q1.7 / K12), data analytics (Q1.8 / K13), and business indicator relationships (Q1.10 / K15) more highly. These responses point to a more substantial interest in the analytical and digital dimensions of the game.

Rather than indicating one superior outcome, the two clusters show that students experienced the simulation in different but complementary ways – some focused on grasping essential business concepts, others on engaging with more advanced, tech-oriented content.

These findings suggest that “Kietas riešutas” successfully addresses a broad range of educational objectives, catering to participants with diverse interests and educational priorities. This dual focus highlights the game’s versatility as a tool for both traditional and modern business education.

The heatmap illustrates the proportion of survey responses per cluster across different faculties, offering insights into the distribution of participants within each cluster. The proportions are normalized, enabling a balanced comparison irrespective of the total number of responses from each faculty.

The EVF and IF faculties demonstrate relatively balanced proportions between the two clusters, with Cluster 1 slightly more prominent (59% for EVF and 55% for IF). This indicates that participants from these faculties are distributed relatively evenly between the two clusters, reflecting a diverse range of responses.

In contrast, MGMF exhibits a strong association with Cluster 0, where 72% of responses are concentrated, suggesting a more unified perspective or alignment within this cluster.

Conversely, the UL_M faculty shows a similar pattern but in favor of Cluster 1, with 72% of responses falling into this cluster, reflecting a distinct difference in the perspectives of participants from this group.

The strong dominance of specific clusters for MGMF (Cluster 0) and UL_M (Cluster 1) may indicate unique faculty-specific factors influencing their responses. This could stem from differences in educational focus, teaching methods, or exposure to the concepts evaluated in the survey.

The balanced proportions for EVF and IF suggest a broader variety of perspectives or experiences among participants in these faculties, while the polarization observed in MGMF and UL_M points to more homogeneous viewpoints.

The heatmap in Fig. 6 highlights meaningful distinctions in how faculties align with the identified clusters. The balanced distribution in EVF and IF reflects diverse experiences, while the concentrated patterns in MGMF and UL_M suggest unique characteristics shaping their responses. Further exploration of the underlying factors contributing to these distributions may provide valuable insights into the variations observed across faculties.

The bar chart in Fig. 7 visualises the proportion of responses per cluster for each faculty, providing a comparative overview of how faculties align with the identified clusters. The proportions are normalised to make it easier to identify patterns in the distribution.

EVF and IF show a balanced distribution between the two clusters. For EVF, Cluster 1 is slightly more prominent, representing just over 50% of the responses, whereas for IF the proportions for both clusters are almost equal. This suggests a diversity of perspectives among participants in these faculties.

MGMF shows a strong association with cluster 0, where almost 70% of the responses fall. This indicates a more uniform orientation towards the characteristics of Cluster 0.

In contrast, UL_M shows a strong preference for Cluster 1, with approximately 70% of responses aligned with this cluster. This clear pattern suggests that participants from the UL_M faculty predominantly share perspectives associated with Cluster 1.

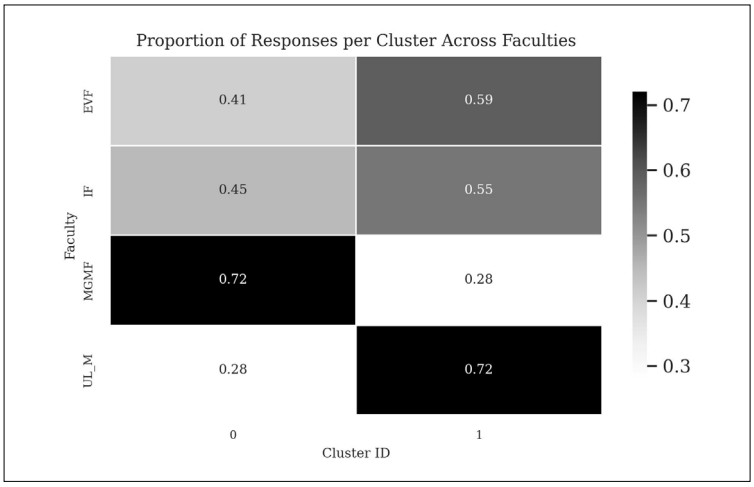



Fig. 6. Heatmap – Proportion of responses per cluster in faculties (Cluster 0 grouping the students that more positively responded to questions about basic business knowledge, Cluster 1 grouping students who responded more positively to questions related to technology and data use)

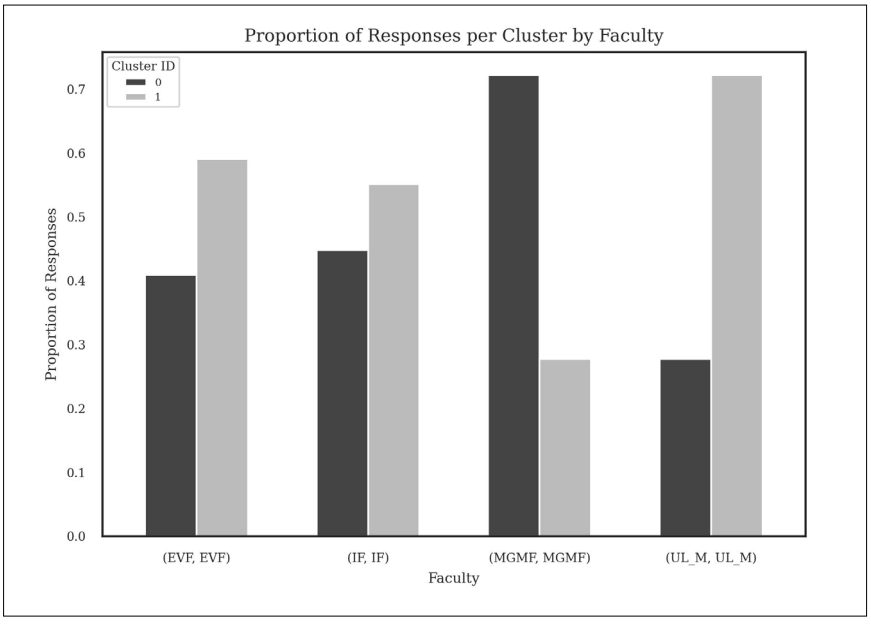



Fig. 7. Bar chart of responses in cluster by faculty (Cluster 0 grouping the students that more positively responded to questions about basic business knowledge, Cluster 1 grouping students who responded more positively to questions related to technology and data use).

The dominance of certain clusters in MGMF (Cluster 0) and UL_M (Cluster 1) suggests faculty-specific influences, such as curriculum focus or exposure to certain business concepts emphasised in the survey.

The balanced proportions in EVF and IF reflect a wider range of experiences or interpretations, suggesting that responses from these faculties are not strongly polarised towards a single cluster.

EVF and IF faculties contribute relatively equally to both clusters, reflecting different points of view or different levels of familiarity with the game's themes. MGMF and UL_M, on the other hand, show less diversity in cluster distribution, indicating a stronger alignment with specific clusters.

The bar chart highlights different clustering patterns across faculties, with MGMF and UL_M showing concentrated alignment with specific clusters, whereas EVF and IF show more balanced distributions. These results suggest that faculty-specific factors, such as pedagogical focus or different levels of engagement with the survey themes, may play a role.

## 4.2. *Comparison of Simulation Results for Different Groups of Students*

The results are presented in Fig. 8, Fig. 9, Fig. 10, Fig. 11, Fig. 12.

Fig. 8 shows that KTU students achieved better results, first of all, higher net profit. They also received less revenue by selling the products, spent less on advertising.

Fig. 9 shows that, while there was this difference between students of KTU and UL, there are also differences between faculties in the same university. For example, while the total net profit in UL was indeed lower than net profit in any faculty of KTU, in sec-

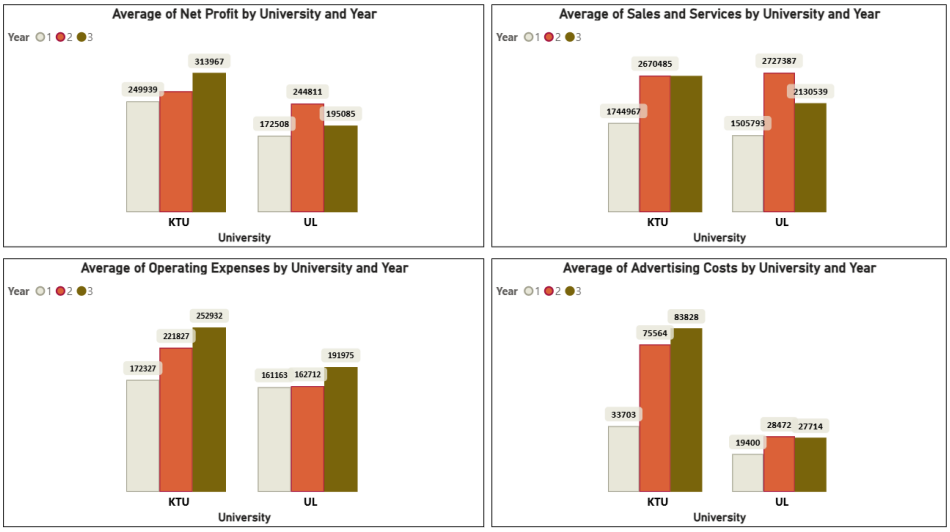



Fig. 8. MS Power BI dashboard illustrating basic financial results in various universities.

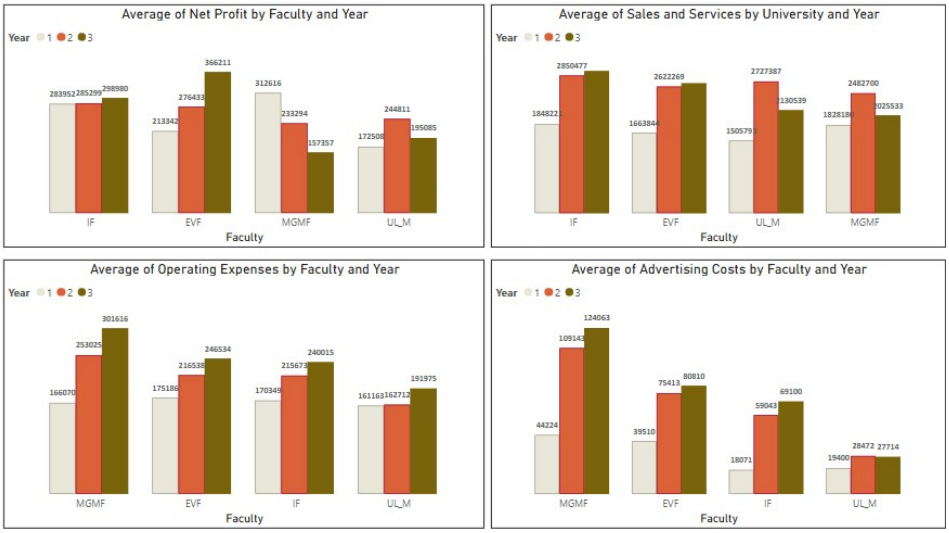



Fig. 9. MS Power BI dashboard illustrating basic financial results in various faculties.

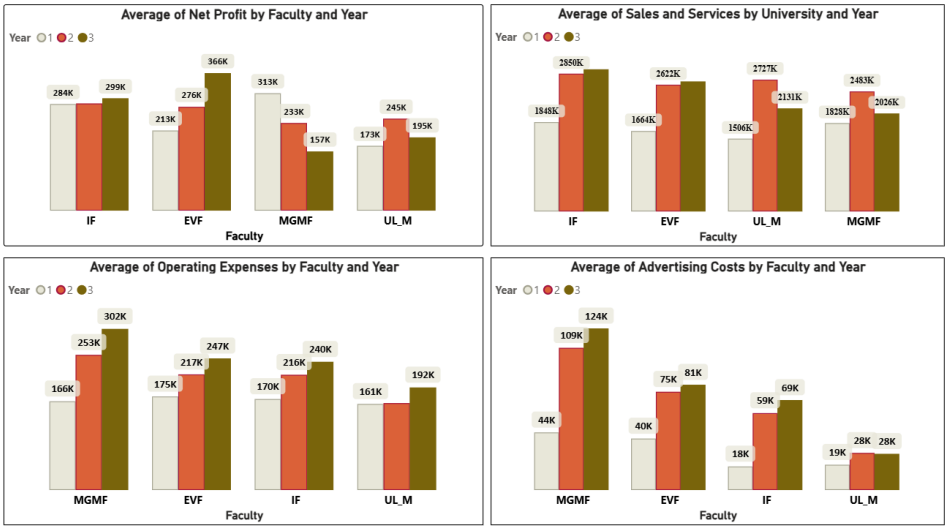



Fig. 10. MS Power BI dashboard illustrating financial results in various faculties.

ond and third year it was slightly higher than in the faculty of Mathematics and Natural Sciences. However, the advertising expenses are clearly lowest in UL.

Fig. 10 shows that, as it could have been expected given that the net profit was low, the capital and reserves (or shareholder equity) were also lowest in UL. However, the differences with other financial results are less noticeable.

Fig. 11 shows that marketing results did not differ significantly between faculties.


Fig. 11. MS Power BI dashboard illustrating marketing results in various faculties.

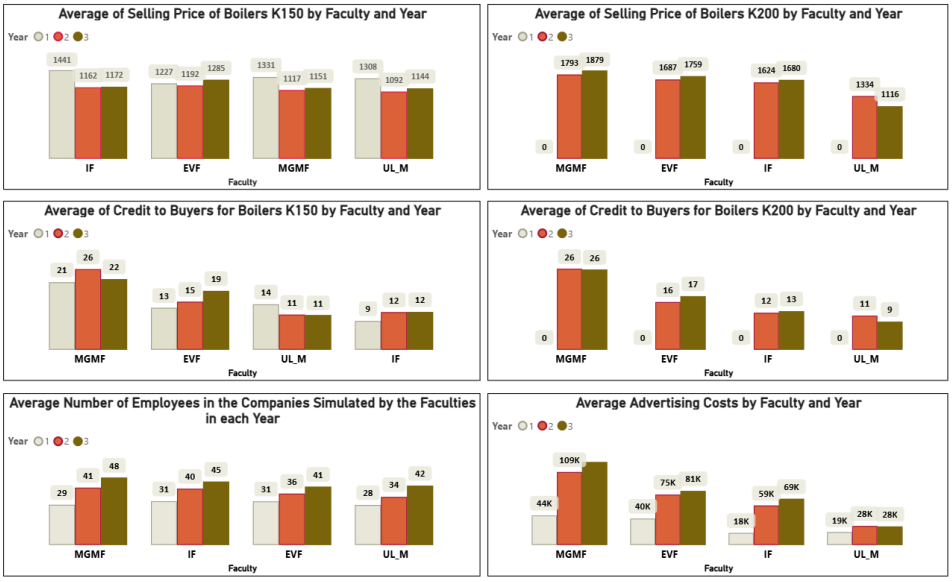



Fig. 12. MS Power BI dashboard illustrating the decisions in various faculties.

Table 4
Average number of tries (with standard deviation) in various faculties in various years

| Faculty | 1st year | 2nd year | 3rd year |
|---|---|---|---|
| KTU EVF | 27.12 (17.43) | 16.68 (10.58) | 26.88 (22.38) |
| KTU IF | 31.21 (14.50) | 16.07 (10.82) | 28.93 (31.58) |
| KTU MGMF | 37.43 (17.33) | 15.86 (6.39) | 35.29 (19.14) |
| UL_M | 20.00 (20.39) | 7.14 (3.80) | 7.14 (6.82) |

However, it can be noted that one financial year one enterprise in UL dominated the marked (with 74% of sales of the second product). Also, enterprises in UL had lower costs (which is connected to lower marketing expenses).

Fig. 12 shows that students of UL tended to give lower credit to buyers, advertising expenses, had lower prices than KTU students.

The lower performance of the University of Lodz students can be explained by the lack of time for decision-making, as well as the lack of sufficient time for data analytics using various IT tools (Access, Excel or Power BI). Another problem was that not enough time was allocated for debriefings.

Despite the significantly shorter time allocated, the University of Lodz managed to achieve good results in the following indicators: Sales and Services (particularly successful in FY2), good sales organisation (especially for the product K200, the marketing indicator was the highest), a good critical appraisal rate and the lowest cost of sales.

Table 4 shows the influence of the time available for the task more directly. It can be seen that the students of University of Lodz were able to make less tries than students of the KTU (in case of year 2 they made about half the tries, on average, while in case of year 3 they made only about a quarter of tries of the students of KTU).

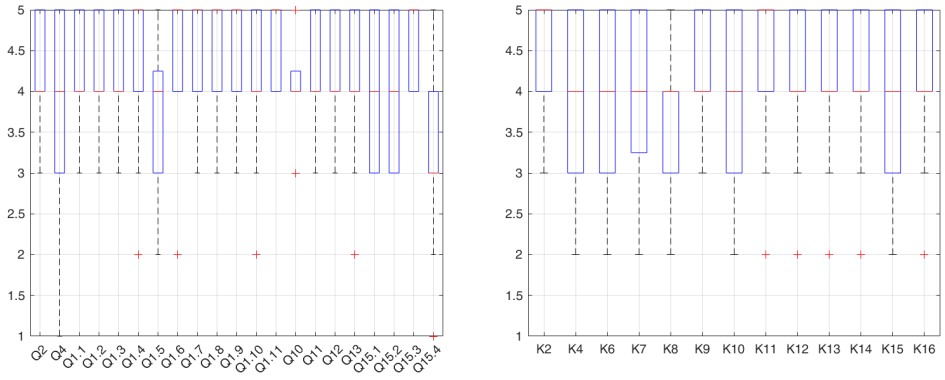
### 4.3. *Analysis of Responses Of Second Survey*

39 students answered the survey, however, two of them did not answer all questions.

As many of the questions in the second survey were in the first survey as well, a comparison was made between them.

Fig. 13 shows that the distribution of answers to various questions was rather similar between the surveys, thus suggesting that the surveys could be statistically valid.

Fig. 14 shows that the students have found Power BI the most useful and generative AI the least useful. It suggests that the students did understand the usefulness of those tools mostly correctly.




(a) (b)

Fig. 13. Box plot comparison between the (a) first and (b) second survey.

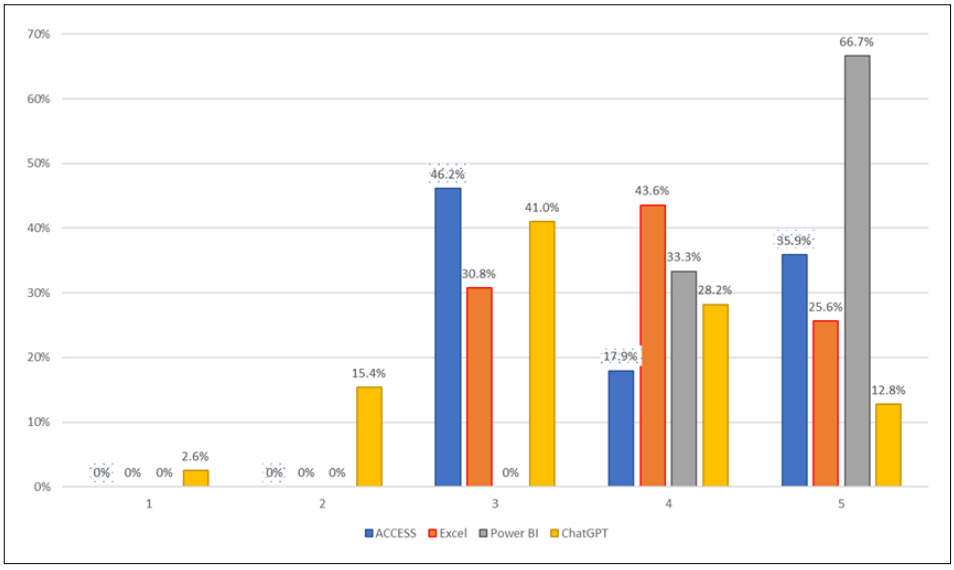



Fig. 14. Comparison between the preference of use of various tools

## 5. Discussion and Conclusions

Educational games aim to facilitate the learner's mastery of the theoretical and practical aspects of the model. The analysis of the literature shows that national products are sometimes difficult to adopt in other countries. The study shows that the computer business game 'Kietas riešutas' meets the needs of both Lithuanian and Polish students. In fact, students from the University of Lodz rated it better than KTU students in some aspects.

The average scores for most of the financial indicators were worse for the students of the University of Lodz than for the students of KTU. One possible explanation for this difference is the difference of time allocated for the game. Another possible explanation would concern cultural and curriculum differences.

A further study would be needed to decide between those hypotheses. In the future, it would be appropriate to introduce this game to foreign students studying in Lithuania. It is expected that it will be included in the study programme for foreign students in 2025/2026. Also, there are plans to include the business game into the study program of University of Lodz in the ordinary way, which might be able to decrease the differences caused by time.

At both universities, the game was played among students with diverse core curricula. In the case of the Polish students, these were students of Linguistics for Business and Digitization and Data Management in Business. Both programs share a similar foundation in management sciences, including process approaches, logistics, and finance. The education system and culture of science and study in both countries are similar (Kumpikaite-Valiūnienė *et al.*, 2016), so differences in results may be due to the adopted teaching method and the language used. In the case of the Polish students, it should be noted that classes were conducted in English and, additionally, they had limited time for group discussion, so it can be assumed that they may have made decisions under time pressure, which could have influenced the results of the stages and the entire game (Payne *et al.*, 1996). Playing the game in a way that allows for a longer analytical and decision-making process, as was the case with the Lithuanian students, allows for in-depth analysis and testing of multiple variants before making a decision.

Several main conclusions could be made:

- The study has shown that the computer business game "Kietas riešutas" is relatively well regarded by both Lithuanian and foreign students. This, in turn, suggests that this business game could be usefully used more widely, perhaps also in other countries.
- The study has also shown that the business game not only helps to understand the purposeful use of information technology, but also motivates people to use it to achieve better game results.
- As the survey validity has been confirmed by this study, such survey could be used in other studies of business games.

Future research should explore how simulations influence rational decision-making, especially under time constraints. AI-based methods, such as machine learning and predictive modelling, could analyse complex patterns of behaviour, uncovering latent structures and revealing dynamics that traditional techniques might miss.

## Funding

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