Applying Simulation in Teaching Selected Courses in Business Informatics with the FlexSim Platform

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Keywords: Education, Simulation Processes, Industry 4.0, New Technologies, Active Teaching, FlexSim, Business Informatics.

Abstract: Using simulation in various sectors as a tool to predict and design processes is very common. The popularity of such solutions is growing, and even in the education field, this kind of tool can be an interesting form of enriching classes. Today, education requires a constant search of methods and instruments that stimulate students' engagement. Active teaching methods ensure students' activities through their creativeness and reactiveness during educational processes. The research aims to investigate the role and usability of simulation, which in turn can be a crucial component of the active teaching method. Education in the Business Informatics area relates to computer technologies and management skills. Our proposals presented in the paper cover both mentioned areas, the simulation of defined business models and the development of applications useful in certain phases of managerial procedures. The application of simulation techniques in education is considered a vital teaching instrument, which allows preparing adequate education, directs students to the proper attitude, motivates them to learn, inspires them and enables their development. This article attempts to fill the research gap by describing the usability of such tools.

1 INTRODUCTION

One of the biggest challenges of modern education is to attract students research and allow them to progress in the extension of their professional skills. It also matters as a way of preparing alternative solutions to defined problems. In addition, all these mentioned aspects are typical of active learning. So, looking for innovative and attractive methods of teaching, we decided to analyse the usability of simulation in teaching selected courses in the Business Informatics major. The Business Informatics major covers different areas of education; apart from general economic knowledge, the studies provide graduates with practical skills in the use of software tools supporting business processes. Students obtain, methods and techniques of analysis and design of information systems, business applications, database technology, design and development of mobile applications and methods of project management. The problems solved by students as part of case studies will enable them to gain analytical skills, flexibility and self-fulfillment of tasks as business informatics professionals (2022, March 08).

The research goal is to investigate the role of simulation in preparing certain projects essential in practical education in selected courses in the major discussed. There are many platforms supporting simulation in teaching; FlexSim seems to be useful as an example in line with this approach. However, this platform is dedicated to preparing individual models, and it is worth analysing how students elaborating

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Binsztok, A., Butryn, B., Holowinska, K., L. Owoc, M. and Sobińska, M.
Applying Simulation in Teaching Selected Courses in Business Informatics with the FlexSim Platform.
DOI: 10.5220/0011084300003182
In *Proceedings of the 14th International Conference on Computer Supported Education (CSEDU 2022) - Volume 1*, pages 330-337
ISBN: 978-989-758-562-3; ISSN: 2184-5026

solutions tend and are able to cooperate, how they may share their results and what level of efficiency is reached in simulations prepared by students' teams.

The paper is organized as follows. After an overview of the state-of-the-art current and available research (in the next section), short characteristics of the platform are presented. Then, two cases of applying FlexSim in two courses are demonstrated. In these cases, we aimed to detect how the applied platform is equipped with mechanisms and measures useful in monitoring students' activities during their work on models. Finally, a discussion of the obtained results with conclusions is described. There is a tangible research gap in the knowledge of using simulation tools in business informatics, in our opinion.

2 LITERATURE REVIEW

The use of simulation techniques in education is considered an important teaching tool; it makes it possible to create a reality adequate to the level of education, directs the student to the appropriate attitude, motivates to them learn, inspires them, and enables their development (Bock and Wiener. 2017). Simulation-based education refers to the use of simulation software, tools, techniques and serious games to enrich learning processes (Ibezim., Asogwa, 2020); (Campos, Nogal, Caliz, Juan, 2020). Games based on simulation offer challenges and autonomy for students while involving them more in cognitive processes. This format is especially attractive for students who are keen on intensive intellectual effort (Chernikova, Heitzmann, Stadler, Holzeberger, Seidel, Fischer, 2020).

The largest number of articles related to simulation modeling concerns ecological modeling. However, as recent studies show, simulation modeling has shifted to healthcare issues (Story, Yukhymenko-Lescroart, Deitz, 2020). Therefore, it is most often used for teaching in the field of medicine. Distinguished simulation methods defined criteria and steps that need to be applied when designing a simulation course as well as developing a skills checklist to ensure that simulation is successfully applied to medical education (Jadrić, Mijač , Ćukušić, 2020). Interactive methods based on computer simulation bring the expected results in improving communication knowledge and self-efficacy among medical students and are well received by them (Heeseung, Ujin, Ye, Chanhee, 2020). In the case of educating students in other fields of study, there are fewer examples of the use of simulations.

Simulation techniques are also successfully used in sports (Eshama, 2020) or in simulating business processes and designing information systems (Emerson, Dunn, Takito, 2020). Previous studies indicate different models of games and simulations and usually refer to the tools used and provide their detailed description. Business process management focuses on various methods, techniques, or frameworks, such as the business process model and notation (BPMN), identification, simulation, evaluation, the improvement (ISEI) method, process based on events, event-driven simulation modeling, educational process management (EPM) structure, social network analysis (SNA), agent-based simulation and TOGAF (The Open Group Architecture Framework), rapid analysis and design (RAD), educational process management (EPM) and the serious game-based method for business process management (Paul, Serano, 2004).

Simulation models fully or partially simulate real processes or systems. Introducing them into the student learning process enables students to find themselves in a variety of realistic circumstances when real practice is unavailable. They can try their hand at running a software development company or carrying out various business processes (Bosilj, Vuksic, Tomicic-Pupek, Bach, 2018).

Teachers are under increasing pressure to empower students to directly apply what they are learning. It is forced by the development of ICT; also, it is required by both students and the industries in which they will work. Implementing business simulations that put students at the center of different scenarios allows them to make their own decisions about real-world business problems (Vakaliuk, Kontsedailo, Antoniuk, Korotun, Mintii, Pikilnyak, 2020).

Publications in this thematic area indicate the following:

- Simulations provide a wide range of practical possibilities/options, enhanced by using the latest technology.
- A higher level of authenticity is related to a more precise design of the simulation-based learning environment.

Simulations offer one of the most effective ways to design learning environments in higher education. The combination of simulation in teaching with the latest technologies is an area that is still relatively little explored. The research gap is to test usability by using simulation methods in the learning process in Business Informatics field.

3 FlexSim AS A SIMULATION PLATFORM

FlexSim is software dedicated to modeling, developing, visualizing, simulating and monitoring processes and activities in companies or organizations. It is used as a tool to perform tasks consisting of 3D simulations, model layout, model building, model analysis and optimizations (2022, March 09). Due to its realistic 3D graphics and complex reports (dashboards can be customized), it is easy to find a problem in the process and prepare suitable solutions. FlexSim is widely used in a variety of industries , from manufacturing to warehousing, by supporting decision-making and answering even the most difficult questions connected with processes. The most important benefits of using Flexsim are (Nordgren, 2013):

- Reducing business risks by using a virtual environment that can be precisely reproduced exactly as in reality to check how particular scenarios work in practice.
- The analysis of cases and scenarios which are more than data in basic spreadsheets.
- Possibilities of implement ingvery realistic 3D visualizations.
- Optimization of the system before implementation in real life, which saves time and money.

FlexSim is a very useful tool to create a variety of simulations. Building models include identifying objects and flows between elements in general structures. A 3D model is built in the main panel, which is the main workspace.

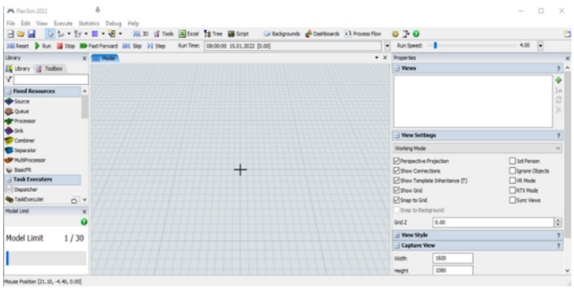

Figure 1: Initial interface supporting Simulation in FlexSim.

Users can construct their models by choosing fixed resources from the menu bar, e.g. Source, Queue, Processor, Sink, Combiner, Separator, MultiProcessor and Basic FR, and put elements in the field designated for the model.

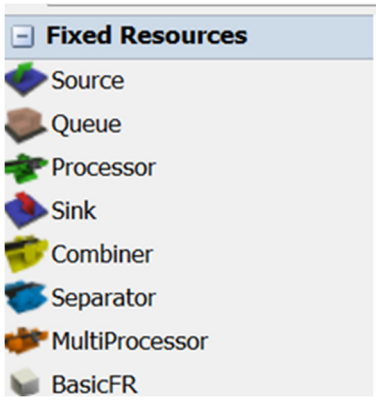

Figure 2: List of categories useful in creating simulations with FlexSim.

All fixed resources have a specific function (e.g., source, which makes flow items with intervals and implements them to the model, queue, supplies items, etc.) In addition, users can also use the tasks executers menu bar, which is list of categories dedicated to performing tasks such as transporting flow items or operating machines. The most popular kind of task executer is Operator, which in the simulation can represent an employee. The Main Menu encloses all tools and commands which can be used while creating a simulation model mainly connected with the administration of the file. The toolbar provides fast access to the most popular commands and tools. The Simulation Control bar includes commands and tools which are necessary to run the simulation and regulate simulation time (2022, March 08).

The architecture of the FlexSim software makes the creation of 3D models and simulations simple and intuitive, but in complex projects, there are possibilities of using many variants of the simulation, also changing the execution time for particular processes, or changing the time of starting the triggers. What is important, FlexSim allows users to choose ready-made solutions and tools or use full customization.

4 SIMULATION OF BUSINESS MODELS USING FlexSim

Taking into account the fact that the FlexSim software allows for intuitive mapping and optimization of advanced processes that take place in the analyzed industry, it is possible to use this tool in very different areas of production, logistics and services. For this reason, this part of the article will focus on the potential of simulation and the FlexSim

tool in the context of conducting classes at an economic university in the field of Business Informatics.

The authors will provide a short description of two subjects/courses which, due to their nature, seem to be particularly predisposed to use FlexSim tools during their implementation and propose example scenarios for conducting classes.

The courses in question are Digitalization of Business Models and E-business in the Age of Industry 4.0.

The *Digitalization of Business Models course* covers, among others, such issues as entrepreneurship, organization and planning in business, organizational structures, business model analysis, market research and branding, opportunity detection, positive persuasion in practice, social responsibility and ethics, team building in the modern companies, motivation in modern companies and information gathering.

The teaching methods used so far are presentations, discussions, case studies, managerial games, active forms of movement ("ice-breakers" and "energizers" stimulating more effective interpersonal communication), team exercises and heuristic techniques (activating creative solving of problem situations) and exercises with the use of video cameras (optional).

During the course, students carry out a research project, whose topic is: "Project preparation – Digitalization of Business Models". The student's task is to develop a model. They should also find examples of interesting business solutions based on a literature review and their observations.

During the classes on the subject ***"E-business in the era of Industry 4.0"***, students learn about the concept of "Industry 4.0", including the distinguishing factors and consequences of the fourth industrial revolution. In addition, they learn in detail the concepts of the e-business model: conditions for the development of this type of model, the impact of ICT on the challenges posed by this type of business, legal aspects of the functioning of e-business and aspects related to knowledge sharing and relationship management in selected e-business models. In addition, they learn about the fundamental principles of creating an e-business model and develop their concepts of e-business models.

The teaching methods used so far in the classes are lecture, seminar lecture and exercises: group work, presentations and discussion. Students of this course carry out a research project covering the following:

- development (in a team) of a concept of an e-business model with assumptions and justification/comments on the selection of individual elements of the model;
- preparation of a multimedia presentation on the developed concept.

Considering the above information, it is possible to propose making the classes in these courses more attractive by introducing simulations as an element of the didactic process, which will make it possible to better illustrate the functioning of selected elements of the business reality, including aspects such as the functioning of specific elements of the business model (e-business), which depend on different variables. It can be, for example, a customer service process in an online store as a key process within one of the canvas business model elements called "key processes". Using the FlexSim simulation tool would present the different possible paths/runtimes of the process and show where the weak points are, and then, with some changes, observe the difference and possibly make further modifications. Students/future managers would learn which elements/activities within the simulated processes are more sensitive and/or influencing the remaining process links and the result, and which are of little importance or can even be eliminated from the process without compromising the final result. Taking into account the fact that FlexSim is easy to use because, thanks to a very extensive library of 3D objects, it is possible to accurately reproduce the analyzed business process, there is a chance to use this tool to conduct classes with students that related to various types of simulations of business activities – e.g. manufacturing of goods on the production line, logistic work in the warehouse or the customer service process in a trading company (see Fig. 3 and Fig.4 – Model and Results of Customer Service Simulation in FlexSim). All this, in turn, would allow the final result to develop flexible and easy-to-configure statistics of processes, which, in turn, would allow the visualization of fully digital business models in modern companies. Therefore, the use of this tool to conduct classes for students learning the subjects "Digitalization of Business Models" and "E-business in the Age of Industry 4.0", where lectures and exercises are mainly based on the concept of Maximilian Bock and Martin Wiener (Table 1), could turn out to be the optimal solution in didactic processes.

Table 1: Digital BM Taxonomy.

Dimension	Characteristics				
Digital offering	Digital products	Digital services	Human services and complementary digital services	Physical products and complementary digital services	Physical products with embedded digital technology
Digital experience	Personalization		Engagement		Community building
Digital platform	Internal integration	Supplier integration	Partner integration	Inbound customer integration	Outbound customer integration
Data analytics	Process and product data		Customer data		(Free) external data
Digital pricing	Demand-based pricing		Supply-based pricing		Consumption-based pricing

Table 2: The three components of a digital business model. An example for a commercial company selling music products via the Internet.

Content What is consumed?	Information	Product information, price and use details, etc. Example: information about a given artist and other artists and music, charts, album reviews, comments from music experts and critics, links to various social networking sites, music fan clubs, up-to-date information on concerts and other cultural events.
	Product	Digital products such as CDs, e-books, e-saver accounts, movies, software, online meetings with musicians, conferences
Experience How is it packaged?	Customer Experience	The experience can include customer-facing digitized business processes, community and customer input, expertise for informed decision making, recommendations, tools and interface; for example, each login to the system based on a subscription may be associated with the strengthening of ties between system users. Here, there can be an exchange of content between customers, i.e. they can exchange their insights in the area of different musical tastes, impressions about the music purchased or feelings from music events and other cultural events.
Platform How is it delivered?	Internal	Other business processes, customer data, technology
	External	Software available only to users of a given system, open public networks, business partners Example: A global music platform adapted locally; highly developed system architecture with global access to various content related to the sphere of music and culture; modular design and global and local content exchange.

A very interesting solution could then be the combination of the above concept of building a digital business model based on the three components of the digital business model proposed by P.Weill and S.Woerner. Based on 3 elements: content, experience and platform (Table 2), it is possible to create an attractive value proposition for the client, which could constitute aninteresting concept, providing inspiration for the future of the visualization of business processes during classes.

The above example of the functioning of a digital music store in combination with the use of the FlexSim tool could be an interesting source of observation for students. They could introduce various variables into the system, such as, for example, the number of participants in the platform, various reviews and opinions, information on planned concerts and other cultural events, as well as many other variables, thanks to which they could simulate changes in revenues in such a trading company or also study how relationships with potential and real customers change.

The first simulation dedicated to the course *Ebusiness in the Age of Industry 4.0.* is presented in Fig. 3. Real objects existing in customer service (recently performed online) are mapped as *Fixed*

Resources in our model, so:

- CustomerOrders represent the Source category in this model,
- *Ordering* and *NewCustomers* play the role of supported *Queue*,
- main actions are performed by *Processors* (*AccountCreation*, *Catalogue* overviewing, defining *Basket* content, and finally *Payments*), and
- final results of order processing (*Failed, NotServed, Waited, and Served* orders) are represented as *Sink* objects.

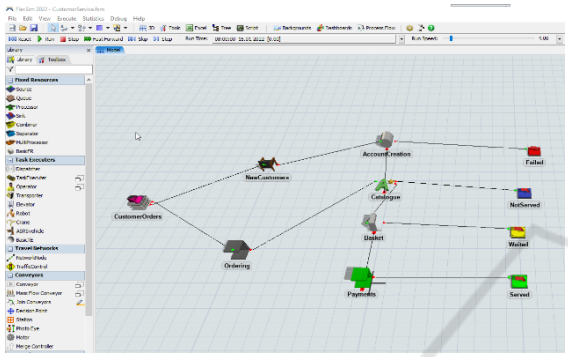

Figure 3: Model of Customer Service Simulation using FlexSim.

Relationships between particular objects, supported by setting parameters for the defined resources, were created to analyze the results of such defined simulation. This version of simulation reflects typical processes present in Customer Service models and should be extended in more advanced research. Before starting the simulation, a specialized *dashboard* was created consisting of selected objects to be analyzed and types of expected charts demonstrating the results of simulation – see Fig. 4.

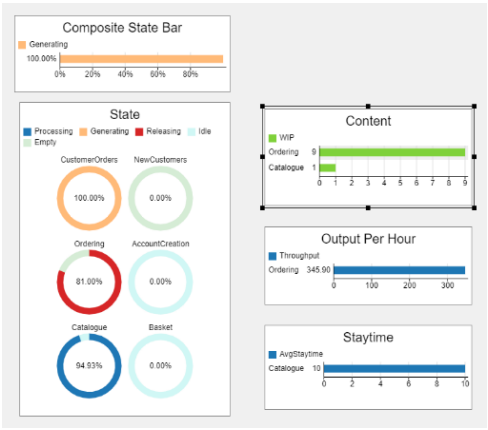

Figure 4: Results of Customer Service Simulation using FlexSim.

The presented charts inform about different aspects of Customer Service including all phases of customer order processing, staytime (customers' Catalogue reviewing), and the efficiency of the determined processors according to the defined parameters for particular objects. The platform is very flexible in terms of objects defined in the model and the preparation of dashboards illustrating the simulation process of customer services.

Summing up, it is very easy to model and make the simulation of more or less complex business processes for managers. Thus, students are able to experiment by creating business models, perform simulations of different processes as well as visualize obtained results.

5 MODELING OF PROCESSING DATABASE TRANSACTION SUPPORTED BY FlexSim

The next group of courses which can be supported by simulation tools is strictly connected with the technological aspects of the Business Informatics major. IT people and students have many developed platforms useful in modeling information systems, designing applications and programming software. However, preparing many variants of the final applications and simulation of data processing in more complex computer systems is still a big challenge for software developers and IT managers. One of such problems, essential in all information systems, is the simulation of database transactions typical of all events-oriented and analytical-based applications. The proposed simulation is prepared for the Databases course, one of the very fundamentals in Business Informatics.

The simplified version of the model presenting database transaction processing is shown in Fig. 5. The main components of the model are as follows:

- Transactions representing Source from the Fixed Resources categories,
- DirectAccess and Authorization belongingto the Queue category; we assume that some database transactions should be additionally verified using a specialized processor while the others can obtain direct access to databases servers,
- The list of Processors responsible for the defined group of transactions (respectively for performed queries and generating reports and more complex tasks: *DBServer0, DBServer1, DBServer2, and DBMultiServer*),

- Outputs of database transaction processing representing *Sink* category diversified on *Failed, Succeed, Reports,* and *Answers* results.

All these components were precisely defined by setting adequate parameters and connected via determined ports.

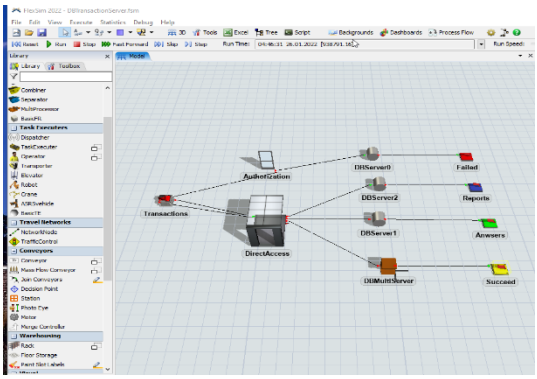

Figure 5: Model of DB Transaction Processing Simulation using FlexSim.

As previously, before starting the simulation process, separate dashboard should be created containing monitored objects with the definition of chart types prepared for a different analysis of the ongoing processes. Compared to the previous simulation, new aspects of simulation have been explored; for example State Gantt of Queue Types or Composite Throughput per Hour visualizations. The results of this simulation are depicted in Fig. 6.

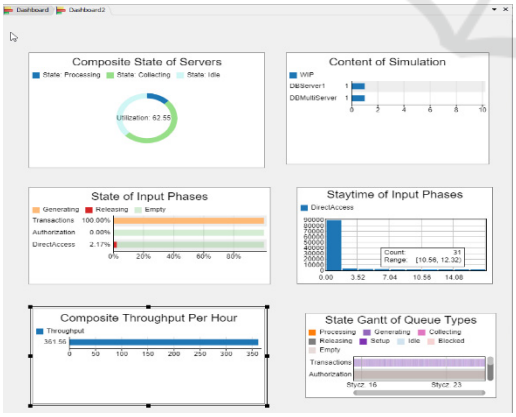

Figure 6: Results of DB Transaction Processing Simulation using FlexSim.

Also, the presentation of technological aspects can be multi-folded and created in a very flexible way. Students can be activated by providing different parameters of the model components and in addition defining several dashboards supporting different methods of monitoring particular servers. In the case of discovering bottlenecks in transaction processing, additional servers can be added or parameters guaranteeing better efficiency can be applied.

Database transaction processing can be visualized using many ways; simulation of real operations performed in many sectors creates the opportunity for students to understand the complexity of all processes served by database machines.

6 CONCLUSIONS

It must be assumed that the more simulations would be carried out in the classroom, the more proficient students could become in assessing various processes. In addition, the use of the FlexSim tool is an opportunity to increase the activity and involvement of students during classes, thus making them a modern form of activity that is attractive for young people whose life and work are already inextricably linked with ICT tools. Teaching in faculties such as Business Informatics should be supported even more by the latest ICT technologies. Simulations and games properly designed in the FlexSim tool (tailored to the needs of selected classes) could be an important element increasing the attractiveness of the course, and above all, students' satisfaction with interactive classes. In the future, it is planned to use the FlexSim tool to analyze and assess to what extent classes using simulation affect student behavior, i.e., whether, for example, they increase student involvement during classes, develop creativity, increase the number of ideas generated, improve the flow of data/information between team members, etc.

It has turned out that active teaching methods are not the optional solution but an inseparable element of today's education. Further research will be performed on more complex models which use monitoring tools that enable the registration of user behavior, i.e., time of work, kinds of undertaken activities, number of logins, etc., and analytics of the obtained data, as well as evaluate the usefulness of the prepared tool and conclude other functions or improvements that can be introduced to optimize the work with the tool.

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