Integrated simulation in the core curriculum of Logistics and Aviation Management studies

INTRODUCTION

Improving education internationally is the greatest challenge of our generation [2, pp. 229]. Incorporation of new technology is the foremost goal in improving the methods of teaching, learning, and exploration of knowledge. The learning environment involving simulations have changed the mindset of the students. Early studies show that gamers perceive the world more clearly, are more creative problem solvers, are more confident, and are more social [6, pp.3] . Usage of simulations during courseware allows students to focus on techniques involved in design process, procedures in logical pattern, problem analysis, alternative considerations, solution generation, implementation and evaluation, idea communication, work assessment and accomplishment, and analyzing impacts. When designed well, both simulations and gaming environments can facilitate students’ learning of both specific domain knowledge and concepts, and several cognitive skills like pattern recognition, decision-making, and problem solving [9, pp.2].

Aviation management involves management of various entities, there by involving different kinds of simulation trainings viz. Airline management simulation, Airport management simulation, crew resource planning simulation, flight-training simulation, and environmental impact simulation etc. In similar way, logistics too involves different entities and hence different simulations are used to make students understand the concepts viz. warehouse simulation, integrated simulation, freight forwarding simulations, and supply chain management simulation etc.

The aim of this article is to provide two application based simulation concepts, which can used in the field of logistics and Aviation Management. In aviation management, airline management simulation will be presented and in field of logistics, freight forwarding simulation will be elaborated. The simulations are designed in the form of games. The participants can play these games under the set of guidelines in order to attain knowledge regarding the subject. Games that include an element of simulation (and a class of simulations that are intended to be ‘played with’ by users) has increasingly high potential in educational sector [8, pp. 20]. Although, trends of games and simulation-based learning are set to increase, there have been few attempts to introduce frameworks that can help and support tutors to evaluate games that can be most effective in their particular learning context including their specific subject areas [3, pp. 206]. Educational strengths of using games and simulations include developing a variety of cognitive objectives, transferable process skills, student-centered learning, initiative, creative thinking, affective objectives, sense of completion, and knowledge integration [5]. The article is divided into various sections highlighting the conceptual part and the application part.

1 AIRLINE MANAGEMENT SIMULATION

As stated before the Aviation management is complex and involves various sub entities. The focus of simulation explained here is Airline management simulation. The decision levels associated with Airline Management simulation is shown in schema 1.
Schema 1 Decision levels in Airline management [1, pp. 5]

Schema 2 shows the conceptualization of the airline management simulation.

As clear from the schema, the participants have to make decisions on various sub entities. Various decisions should be based on the existing information with the aim of maximizing profits and/or obtaining adequate interest on the capital invested. All the participants of the game will be provided with the initial business conditions to start the business in a competitive market. The simulation game will be played in various stages. At the beginning of a stage, the participants will make the decisions and information related to the results will be intimated to them at the end of each stage.

1.1 Airline Business Modeling

In this sub section, the participant have to decide regarding the business model i.e. if they want to focus on passenger, cargo, or both. In addition, for passenger business they have to decide whether they will operate as Full Service Network Carrier (FSNC) or Low Cost Carrier (LCC) or Hybrid carriers. The assumption to be made in this section is that the airlines cannot operate same aircraft for cargo and passenger i.e. they cannot carry cargo in passenger aircraft belly. For transporting cargo, they will have to use the dedicated aircraft and see the cargo business as traditional cargo business.

1.2 Route and network planning

Depending on the type of business model selected by the participants, they will perform route and network planning. At the initial stage, a closed market structure will be provided. This market will consists of four airports at different locations and role of participant airlines’ will be to transport Pax and cargo between these four airports. All the information related to the airport viz. infrastructure, charges, flight time between airports and demand will be provided in advance.
1.3 Aircraft and crew planning

After evaluating and taking decision in accordance with demand, the participants have to select aircraft and plan crew from these aircraft. The manufacturers offer passenger and cargo aircraft. Cargo cannot be transported in passenger aircraft. Table 1 shows the information regarding a/c and crew, which will be provided to participants.

Tab. 1 Information regarding aircraft and crew [Own research]

<table>
<thead>
<tr>
<th>Aircraft type</th>
<th>Passenger Aircraft</th>
<th>Cargo Aircraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price (in thousand PLN)</td>
<td></td>
<td></td>
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<tr>
<td>Number of seats (Passenger version)</td>
<td></td>
<td></td>
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<tr>
<td>Cargo capacity (Cargo version)</td>
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<tr>
<td>Insurance costs per stage (in thousand PLN)</td>
<td></td>
<td></td>
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<tr>
<td>Max. flight hours before D-check</td>
<td></td>
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<tr>
<td>D-check duration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-check material costs (in thousand PLN)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries in thousand PLN per crew (cockpit and cabin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training costs per crew in thousand PLN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landing fees in thousand PLN per landing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range in flight hours</td>
<td></td>
<td></td>
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<tr>
<td>Fuel consumption in liters per flight hour</td>
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</tbody>
</table>

1.4 Technical services and handling

Technical service and handling includes the information regarding maintenance, overhaul, Personnel in the technical department and the station handling. Based on this information, the participant have to take appropriate decisions for their airlines.

1.5 Supply of material

In order to safeguard flight operations it is advisable to take into account the supply of spare parts and other necessary things at the airports. The distribution of supply, emergency availability should be also taken into account.

1.6 Human resources and administration

Human resource and administration has to take care of the handling staff at the airports, the technical staff, the sales representatives, the flying personnel and the staff in the administrative sectors. These include the employees in Planning, Marketing, Accounting, Personnel and in the Field Sales Organization.

1.7 Marketing and sales

In this department, the participants have to take care of the following:
- Market relationships
- Marketing instruments
- Advertising
- Sales promotion
- Acquisition by sales representatives
- Service frequency
- Service level

1.8 Finance and accounting

In Finance and accounting department, participants will have to take care of the following:
Simulation tools have been used by transportation professionals to evaluate and analyze the potential impact of design or control strategy changes [4, pp.12]. As instructors continue developing useful learning tools for their classrooms, games have become one popular alternative. An effective game will help students understand concepts more quickly and remember them better than from a lecture [7, pp. 1]. Logistics sector being one of the most globalized sectors uses simulations for various purposes. Covering the full scope of the logistics sector is beyond the scope of this simulation game.

The scope of this simulation game is to provide the students the knowledge of the freight forwarding business and its related processes in much detail. The main aim is to make students understand the flow of goods from origin to destination. The students will be involved in decision making to make the flow of goods smooth, efficient, and profitable.

As a rule of exceptions and to make players understand the overall processes of the logistics business in detail, some aspects of the traditional forwarding companies is modified. The primary modification will be in the business model. The players will have to manage all processes related to delivery of goods from clients to customers, which is not in case of traditional forwarders who are in majority responsible for selling capacities. The schema 3 below shows the scope of the logistics industry, which will be considered in this particular case.
2.1 Brief Description

The following section describes background of the simulation game. Any number of participants can play the game. The game will take place in a closed market. Each group will be working as a self-dependent company responsible for delivering the goods from origin and destination. Each group will be working in competition with the other companies i.e. the other groups. The participants have to take tactical decisions to be successful in the business. The decisions will be defined later in the subsequent sections. The main aim of the participants will be maximization of profits in highly competitive environment.

The total market coverage will be divided into 4 sections namely, market 1, market 2, market 3 and market 4. Each group will start the company in market 1 and will transfer goods from market 1 to other markets. Market 1 will be consisting of viz.15 suppliers willing to transfer goods from market 1 to market 2, 3 or 4, shown in schema 4. These suppliers will generate the overall demand in the market 1. Each of the suppliers will be requiring different level of service at different point of time. Participant can use any mode of transportation to transport. The performance of each company is evaluated using provided key performance indicators. At the end of the game there will be competition analysis done in a centralized server in order to highlight the impact of the competition like price wars, service level etc. To make participants understand the concept of business and impact of decision making on the company working and profitability in an extremely clear way, the game will be played for six stages, each stage will be 6 months long. At the end of each stage, the companies will be evaluated. Schema 4 shows the sample market structure.
2.2 Details of various parameters

This subsection will provide insight into various parameters in the game.

2.2.1 Specifications of Market

Specification of market will provide the information related to the market situation. The key points to be taken into account while developing market specification are as follows:
- Types of goods.
- Service requirement for transporting goods from suppliers. Schema 5 shows types of services taken into account while delivering.

2.2.2 Companies decisions

Taking decisions to fulfill company goals is the main task of all the participants. Participants have to take decision regarding,
- Infrastructure (Warehouses, office, service stations for employees)
- Employees
- Transportation (fleet management and network management including sort windows at the warehouses)
- Equipment at warehouses
- Services to be offered
- Ordering different marketing instruments including market surveys, demand analysis and competition analysis
2.3 Key Performance indicators

These indicators will determine the performance of each company. In addition to the performance, these indicators will be also used to develop competition analysis. The indicators are as follows:

2.3.1 Efficient order processing

The duration of order processing is included in the delivery time for a good. Speedy and precise processing has a promising effect on the entire flow of goods. As a result, a company should always pay special attention to efficient processing. The capability and efficiency of order processing must be evaluated regularly using indicators that track the reliability and flexibility of order handling. The efficiency of the order-processing subsystem is shown through a comparison of performance and cost contained in a system of key indicators. Efficiency is considered the number of orders processed in a handling period, a cycle that can vary by company. The order-processing costs per order and order-processing reliability are the indicators to be used to highlight the efficiency of the order processing. Formula 1 and 2 provides the insight into the calculations.

\[
\text{order-processing costs per order} = \frac{\text{order-processing costs}}{\text{Number of processes orders}} \quad (1)
\]

\[
\text{order-processing reliability} = \frac{\text{number of orders processed on time}}{\text{number of received orders}} \quad (2)
\]

2.3.2 Warehousing

Operating figures are needed in order to evaluate warehouse’s efficiency and effectiveness. In the process, quantitative indicators for both capacity utilization and movement processes must be used. Expenditures include the warehouse’s capital costs, equipment, and payroll. The tasks of a warehouse can be divided into time-bridging processes when the goods are stored and movement processes associated with storage. These must be depicted in a system of key indicators in order to determine efficiency and effectiveness. The resulting efficiency indicators are storage capacity, the number of available storage positions and stock movements. On the input side, they are matched by performance measures of warehousing costs, which are divided into personnel costs and operating costs. Formula 3, 4, 5, 6, and 7 provides the calculation steps to determine warehouse performance.

\[
\text{Capacity-utilization rate of the warehouse} = \frac{\text{occupied storage locations}}{\text{warehouse capacity(storage locations)}} \times 100\% \quad (3)
\]

\[
\text{Average warehouse costs} = \frac{\text{warehouse costs}}{\text{number of locations}} \quad (4)
\]

\[
\text{Average movement of goods cost} = \frac{\text{warehouse costs}}{\text{goods movement}} \quad (5)
\]

\[
\text{Average personnel costs movement} = \frac{\text{personnel costs(warehouse)}}{\text{movements}} \quad (6)
\]

\[
\text{operational utilization rate of the warehouse} = \frac{\text{actual operational hours}}{\text{estimated operational hours}} \times 100\% \quad (7)
\]

2.3.3 Transport system

Systems of transport indicators are designed to determine the efficiency of transport. Correct approach has to be undertaken to determine how well the transport has performed in terms of quality and effectiveness. To determine this, systems of transport indicators are designed. By using these indicators, the cost and performance of the transport systems being examined can be consistently analyzed and compared with them.

The efficiency of transport can be determined using a system of key indicators. This review focuses on the transport costs, the related capacities, and the quantitative efficiency of the transport. In addition, the specific qualitative efficiency of the selected means of transport must be considered in evaluating the productivity of the transport system. The calculation used to determine the indicators are provided in formula 8, 9, 10, and 11.
2.3.4 Delivery service

Delivery service includes key indicators to determine the reliability and quality of the service provided to the customers. Formula 12 and 13 shows the two indicators used to determine the delivery service.

\[
\text{Delivery reliability} = \frac{\text{number of on time deliveries}}{\text{total number of orders}} \times 100\% \tag{12}
\]

\[
\text{Delivery quality} = \frac{\text{number of complaints}}{\text{total number of deliveries}} \times 100\% \tag{13}
\]

2.3.5 Financial Indicators

The financial indicators include the following:

- Balance sheet
- Profit and loss account
- entrepreneurial return
- corporate return
- cash value added (CVA)

2.4 Role of Game Moderator

The role of game moderator is to take care of the game proceeding and provide the following information, whenever necessary.

- Economic development in regions, current and forecasted.
- Primary demand in the markets.
- Transportation costs for different modes of transportation, delays factor for each mode of transportation, failure rate, and maintenance costs.
- Equipment costs, their capability and workforce requirement.
- Number of employees required for warehouses depending on the capacity and order processing.
- Determine initial funding available for companies at startup.
- Development costs and associated cost.
- Minimum salary for each category of employee.
- Regional wage levels.
- Stock exchange rankings.
- Dividends to shareholders.
- Interest rate on loans and securities.
- Delivering different instruments as required or ordered by companies viz. future demand, market sensitiveness, average salaries.
- Reports viz. financial, operational.

CONCLUSION

- Incorporation of new technology is the foremost goal in improving the methods of teaching, learning, and exploration of knowledge.
- Well-designed games and simulations can prepare students to learn critical problem-solving and decision-making skills necessary for the real world.
- Simulation games are firmly rooted among youth when designed well, games can truly be an important teaching tool.
They promote numerous cognitive benefits in learners, including a facilitation of increased interactions, motivation for learning, visualization, experimentation, self-efficacy, self-monitoring, problem-solving and critical thinking – abilities.

The design of games and simulations is sophisticated and challenging enough for students to be cognitively engaged with the game.

The content of games and simulations has to be aligned with the standards and viable curriculum in schools.

The feedback and assessments embedded in the games embodies the measurable learning outcomes.

The participants’ guides accompanying the games provides sufficient ideas, activities, and resources to enhance students learning.

Exploratory interactive games are useful for Aviation Management and Logistics, particularly when concepts are difficult to visualize.

Aviation management and Logistics involve management of various entities, there by involving different kinds of simulation environments.

Students’ while engaged with simulations provokes experimentation, discovery and learning in them.

Both resource-deprived and resource-affluent students, make significant learning gains after playing well-designed simulation games.

Number of frameworks has to exist in order to guide and support the evaluation of the educational simulation software.

Most simulations meant for educational purposes focus upon either the representation of the game or simulation or upon the practice of using games and simulations.

The facilitation of various resources is more critical and reflective for embedding games and simulations.

The benefit of inclusion of the simulation games in the core coursework of Aviation Management and logistics framework is flexibility, ease of use, ability to reflect upon learning processes and approaches, provision of support to develop practice and embed tools into the classroom and supported reflection and effectiveness.

Abstract
The integration of the simulation in the field of logistics and Aviation Management provides an insight into the practical aspects of the business. It provides a tremendous value added in the study environment. The curricula including variety of simulation-based courses provides a blended course structure, which is much sorted by the today’s industry. Simulation employs various techniques for practice and learning, re-placement and amplification, and evocation and replication of substantial aspects of the real world in an interactive way. Simulation-based learning develops the persons’ knowledge and skills in order to avoid the risk of business outcome due to some bad decision. Simulation-based curricula can be applied in designing structured learning experiences that can be used as a measurement tool linked to targeted teamwork competencies and learning objectives. The coursework conducted in the simulated environment offers an additional benefit to the traditional didactic instruction. Simulations also provide a fertile learning environment for students. The use of simulated activities in education is widely becoming recognized. In the field of logistics and Aviation Management, simulations are often cheaper to create than their real life equivalents. In logistics and Aviation Management, simulation can simulate an activity that is "real", hence creating a virtual real activity.

Zintegrowana symulacja w podstawie programowej studiów z obszaru Logistyki i Zarządzania Lotnictwem.

Streszczenie
Integracja technik symulacyjnych w obszarze Logistyki i Zarządzania Lotnictwem zapewnia wgląd w praktyczne aspekty prowadzenia biznesu. Zapewnia ona ogromną wartość dodaną w środowisko studiów. Programy zawierające różnorodność przedmiotów opartych na symulacji zapewniają im strukturę mieszaną, która jest dużo lepiej przesortowana przez dzisiejszy przemysł. Symulacja wykorzystuje różnorakie techniki dla
zdobywania praktykowana i nauczania, zastąpienia i wzmocnienia oraz przywołania i replikowania istotnych aspektów realnego świata w sposób interaktywny. Nauka bazująca na symulacji rozwija wiedzę i umiejętności, które kierowane są na uniknięcie błądów w prowadzeniu biznesu spowodowanych podjęciem złych decyzji. Programy oparte na symulacji mogą być zastosowane w projektowaniu dowiedzeń z zakresu nauczania strukturyzowanego, które może zostać wykorzystane w narzędziu pomiarowym połączonym z celami nauczania oraz kompetencjami z zakresu pracy w zespole. Praca przeprowadzona w symulowanym środowisku oferuje dodatkowe korzyści do tradycyjnych instrukcji dydaktycznych. Symulacja zapewnia również urodzajne środowisko pracy dla studentów. Wykorzystywanie symulacji w edukacji staje się szeroko rozpoznawalne. W obszarze Logistyki i Zarządzania Lotnictwem, symulacje są często tańsze do stworzenia niż ich ekwiwalenty z życia codziennego. W obszarach tych, symulacja może symulować działania, które są "prawdziwe", stąd też kreować działania wirtualnej rzeczywistości.

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