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Transforming Logistics Education by a Virtual Logistics Simulation Generator: UX Pilot Study

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***Abstract*— In the era of Industry 5.0 and the impact of the changes in the supply chain, educational institutions, SMEs, and the labor market are challenged by technological advancements. The "Simulations for Learning" (S4L) project responds to this challenge by introducing the Virtual Logistics, asimulation generator platform designed to transform logistics education through enhanced decision-making skills and customizable simulations. This tool allows students to design and adapt logistics networks, tailoring their educational experience to real-world logistics scenarios, and by doing so, creating simulation-based serious games. A pilot study was conducted with 249 students from eight universities across five Latin American countries to assess the usability of this simulation generator on logistics education. The study revealed significant findings: (a) the simulation generator provides learners with flexible and tailored educational experiences. (b) the Interface and Performance and Effectiveness aspects of the Virtual Logistics were highly rated, achieving an "Excellent" usability level; (c) however, Content Organization and Navigation were perceived as slightly less effective, receiving a "Good" usability rating and highlighting areas in need of improvement. These results demonstrate student's satisfaction, and therefore, the transformative potential of simulation-based learning tools in logistics education. Virtual Logistics offers valuable guidance for educators, policymakers, and industry leaders, aligning educational tools with dynamic requirements, ensuring that future professionals are well-equipped to face the complexities of the modern logistics landscape.**

Keywords*— Simulations, user experience, complex thinking, educational innovation, higher education.

I. Introduction

Gamified modelling and simulation frameworks in logistics education optimize real-world problems and enhance planning methods in industry and business. Business simulation games in higher education and employee training improve decision-making and comprehension of dynamic logistical scenarios [1], [2], [3]. Close interaction with the business sector allows the opportunity to address real business cases and offer solutions with scientifically validated data, representing a significant opportunity for skills development and knowledge transfer.

Consistently, the training industry in the United States showed increasing interest in gaming and simulation tools in 2021, with 21% of companies surveyed anticipating their acquisition [4]. Close collaboration between academia and industry fosters a mutually beneficial relationship and reinforces the relevance of higher education in addressing contemporary business challenges. Generating social impact and promoting sustainability are critical aspects. The creation of simulators adapted to the needs of small and medium-sized businesses (SMEs) opens the door to significant improvements in the quality of life of entrepreneurs.

Game-Based Learning (GBL) harnesses the immediate feedback of games, outperforming traditional educational methods by enhancing critical knowledge sharing. Serious games focus on education over entertainment, aiming to impart knowledge or skills. Simulations, a form of serious games, replicate reality to provide training, entertainment, or explanations. They are used extensively in GBL for interactive and human-centric learning experiences [28]. The creation of a simulator generator presents an opportunity to transform higher education in the field of logistics. To prepare professionals and entrepreneurs for complex business environments, the integration of innovative experiences and simulations that relate to real-world contexts is needed [5] [6]. This article presents a pilot study on the transformative Project "Simulations for Learning" (S4L), aimed to leverage games and simulations to enhance learning in the field of logistics. The main objective is to evaluate user experience in the support decision-making processes with a Generator of Simulations named Virtual Logistics that aims to provide flexibility and customization to supply chain simulations, allowing students to shape their logistics networks and introduce new elements into the simulation. The pilot involved the participation of 249 students from 5 countries and 8 universities of Latin America. Results show that the generator of simulations represents a promising step toward empowering people and fostering small business growth and sustainability through dynamic and adaptive educational experiences. These advances not only prepare students for the future but also help close the gap between the demands of the labor market and the skills of university graduates.

II. Game-based Learning, Simulations and Complexity

Game-Based Learning (GBL) has gained significant prominence in recent years [7]. This pedagogical approach leverages games and simulations to achieve educational objectives. However, the diversity in the design and implementation of educational games has posed challenges in research and practice [8]. Despite these challenges, GBL remains promising in sustaining student engagement and fostering deeper learning in immersive environments.

The use of educational simulations has seen a surge over the past decade [9], [10]. These simulations offer students the opportunity to practice and develop skills in simulated environments that often mimic real-world situations. This enables them to overcome limitations and risks associated with direct practical applications. Moreover, simulations provide valuable educational support opportunities, facilitating the learning process across various fields [6].

Higher education faces the challenge of integrating complex thinking competencies into its academic programs to prepare emerging professionals for modern demands [11], [12] [5]). This necessitates innovative experiences and support structures that effectively connect these skills to real-world contexts. Simulations play a crucial role in this process as they allow students to develop complex skills in simulated environments before encountering real-world situations. This preparation significantly enhances students' adaptation to the demands of the professional world and is directly related to the evolution of contemporary pedagogy [13].

III. Transforming Logistics Education

Simulations, which offer diverse scaffolding mechanisms, present valuable opportunities for the development of skills across various. In Logistics Education, the utilization of gamified modeling and simulation frameworks has demonstrated the potential to optimize solutions for real-world challenges while enhancing planning methodologies within industry and business settings domains [2], [6], [14], [15]. In addition, in the context of higher education and employee training, the integration of business simulation games has proven to enhance decision-making capabilities and deepen comprehension of dynamic to adequately prepare professionals and entrepreneurs for the challenges of contemporary business environments, there is a compelling need to incorporate innovative experiences and simulations closely connected with real-world [16], [17].

A simulation is a model or representation of a system, process, or phenomenon in which certain aspects or behaviors of reality are imitated. Simulations are used to understand, analyze, experiment, or predict the functioning of something without actually taking action in the real world [18]. Simulation is valuable because it provides a safe and controlled environment to examine and understand complex systems, as well as to forecast potential outcomes without incurring costs or associated risks [19], [20]

In the context of computer science and technology, simulation is often performed through software programs that mimic the behavior of physical or abstract systems. These programs enable designers, engineers, or scientists to test and analyze situations in a controlled environment before implementing them in the real world [21], [22]. For example, in flight simulation, flight conditions are recreated to train pilots without the need for an actual aircraft [23].

On the other hand, logistics represents the management and coordination of all processes involved in the flow of goods, services, information, and resources from a point of origin to the point of consumption [24]. The primary goal of a logistics system is to optimize the efficiency of these flows, minimize costs, and enhance customer satisfaction. These systems typically encompass a variety of activities, such as supplier sourcing, procurement, storage, transportation, and distribution, among others. Logistics is applied across various sectors, including manufacturing, retail, services, and, more recently, it has become crucial in the realm of e-commerce 25].

When conducting a simulation to represent a logistics system aimed at teaching participants decision-making in this field, it is desirable to include various key elements to provide an effective learning experience [26]. Some of these elements should include: 1. Establishing inventory management as a key element of logistics. The simulator should depict how inventory planning, replenishment, and management are carried out to efficiently meet demand; 2. Generating transportation and distribution elements. Simulate the transportation of goods and effective distribution from the source to the destination. This includes route planning, fleet management, and optimization of transportation modes; 3. Introducing cycle times. This involves considering the times for each stage of the logistics process, assessing production times, setting capacity constraints, determining delivery times, and representing order processing; 4. Representing various logistics facilities. This entails identifying the location of suppliers and raw materials, establishing factories and workshops, depicting distribution centers, service providers, stores, warehouses, and the existence of wholesale customers; 5. Characterizing demand at each point of sale. This should help generate equations and formulas to represent market behavior at each point of sale; 6. Incorporating a table of logistics indicators. These key performance indicators (KPIs) will be used to assess the performance of the logistics system. This may include metrics related to efficiency, costs, and service quality.

The simulation should adhere to reality, providing users with a practical understanding of the challenges and decisions they face in logistics management. Furthermore, it should allow participants to comprehend complex systems, experiment with the relationships between different variables within the system, experience the consequences of their decisions, and provide a meaningful learning experience for students.

IV. Virtual Logistics

A. *Virtual Logistics Design*

For the design an iterative methodological approach was adopted, integrating interdisciplinary expertise in a collaborative effort to meet the specific needs of logistics education. Through qualitative data collection, including semi-structured interviews with logistics specialists, the iterative design aimed at developing a digital tool that facilitates learning in logistics planning and decision-making. This process highlighted the necessity for a simulator that is both user-friendly and capable of modeling the complexities of the entire supply chain process, tailored to enhance the competencies and skills vital for logistics professionals.

The iterative design methodology underscored the importance of incorporating feedback from a diverse group of experts, leading to the development of a logistics simulator designed to offer an immersive learning experience. This simulator aims to simulate the entire supply chain, from raw materials to the final consumer, enabling users to navigate and improve upon logistical challenges in a risk-free environment. The design emphasizes the critical skills and technical knowledge required in the logistics sector, advocating for a comprehensive educational tool that fosters systems thinking, analytical problem-solving, and strategic planning in the context of logistics management.

B. *Virtual Logistics Description*

In the development of the Virtual Logistics generator of simulations, the recreation of the main elements enabled the characterization of a supply chain adequately. Figure 1 illustrates the creation of a logistics network using this simulator generator. On the left side of the figure, can be named the game and the company, defined products, raw materials, subcomponents, and created relationships between the quantity of raw materials and subcomponents used in each product. Furthermore, it can be observed that on the right side of the figure (highlighted in pink), there are elements that can be added to the logistics map on the right side of the figure.

Initially, the right side represents a "blank canvas" where to incorporate factories, stores, suppliers, distribution centers, and wholesale customers. Additionally, depending on the number of actors and the characteristics of the network, it is possible to establish transportation elements and create a distribution network that connects the different components.

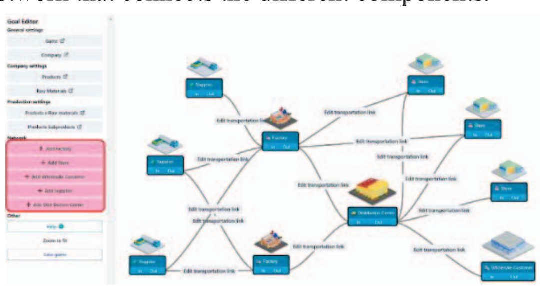


Fig. 1. Creation of a logistics network using this simulator generator.

In each transportation link, you can edit the characteristics of that route. When entering transportation editing, you can establish characteristics related to the type of transportation, cycle time, associated costs, and transportation dimensions (see Figure 2).

Fig. 2. Transportation editing

Each facility can be represented with characteristics that allow the chain to be flexible. For example, with suppliers, you can define the raw materials they deliver, quality, price, delivery

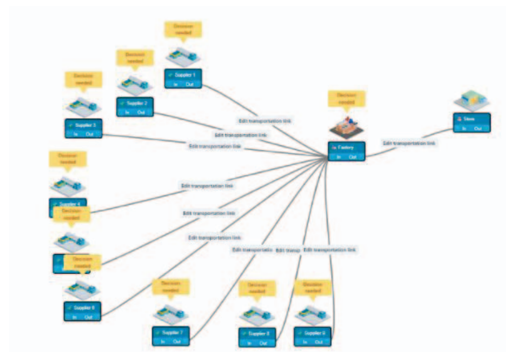


Fig. 3. Elements for decision-making

times; factories allow to simulate the number of machines used, production capacity, costs, storage space, the existence of service providers, and you can define shipments to other chain facilities; stores allow you to establish the type of products sold there, simulate the demand behavior for each product; distribution centers allow to set storage space and the maximum number of units that can be received or shipped. Once the chain has been characterized, a compiler is run to make the program executable, creating a game. In this case, the software indicates in which of the different elements players must make a decision (see above in Figure 3). When making each decision, different charts and indicators appear that provide information about the elements that need to be considered when making that decision (see Figure 4).

Fig. 4. Charts and indicators

The simulator is introduced as a component within a Learning Management System (LMS) platform, which contains open educational resources (videos, infographics, glossaries, among others) that accompany the user and allow for a deeper understanding of both the design of logistical chains and the use of free games. Furthermore, users can access learning paths specifically designed for different levels of complexity, based on logistics case proposals, and integrate tools for assessing the immersion experience, complex thinking evaluation, and self-directed learning. Users can then view their results by accessing a dashboard (see Figure 5).

Fig. 5. Virtual Logistics Platform

V. Pilot Methodology

A. Participants

Participants were 249 engineering university students from five Latin American countries and eighth universities. presents the distribution of students across various universities in Latin America, with ITESM in Mexico having the highest enrollment at 155 students (62.25%), followed by EAFIT in Colombia with 50 students (20.08%), and other institutions contributing smaller percentages to the total of 249 students (UNIVA,México, 4.42%; UDELAR, Uruguay,1.61%; UBA, Argentina, 1.61%; IPVG, Chile, 5.62%; UNAD, Colombia, 4.02%, and TESCHA, México, 0.40%.

A. Instrument

To collect information about user experiences, a UX instrument [27] was used. The instrument was chosen because it is a questionnaire aimed at assessing usability. Feedback from the questionnaire reveals the strengths and weaknesses in various aspects of usability: Content Organization, Navigation, Interface, and Performance and Effectiveness, enabling designers and developers to make targeted improvements based on these insights.

B. Data collection

The pilot test of the Virtual Logistics generator of simulation was designed and executed during August to October 2023. To this end, the pilot was prepared by clearly defining the objectives, identifying the target audience and recruiting participants who represented the intended user group, which included students in careers linked to logistics.

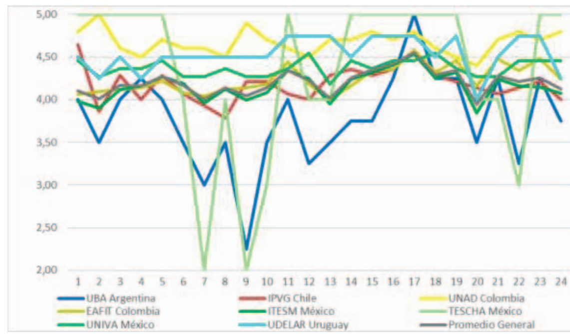
The pilot was delivered in a web based application. It included a series of orientation videos on the following contents: presentation to participants of the purpose and configuration of the generator of simulations, key functionalities such as the construction of logistics networks, the definition of products and raw materials, the configuration of factories and production processes, specifying store characteristics and demand patterns, and modeling distribution centers and customers.

After engaging with the simulation generator, participants shared feedback through a user experience instrument, which evaluates interactions across four dimensions: Content Organization, Navigation, Interface, and Performance and Effectiveness. The instrument, designed to gauge user experience, examines the simulator's content relevance, accessibility, and structure (Q 1-6), navigational ease and consistency (Q 7-12), interface design and aesthetics (Q 12-18), and operational performance and efficacy (Q 18-24).

VI. Results

Graphic 1 presents the cross-country user experience evaluation of the simulations generator, featuring responses from Argentina, Chile, Colombia, Mexico, and Uruguay, scored on a 1 to 5 scale across 24 questions.

Graphic 1 shows the distribution of responses from students participants grouped by University, classified by question.



Graphic 1. User experience responses, distributed by university.

Overall, the data shown in Graphic 1 indicates a generally positive user experience, with an average score of 4.20. The scores exhibit some variability, reflecting differences in user satisfaction and experience across countries and questions, but they consistently lean towards a positive evaluation, highlighting the platform's overall effectiveness in user engagement and satisfaction.

Analysing the user experience evaluation across the four dimensions—Content Organization (Questions 1-6), Navigation (Questions 7-12), Interface (Questions 12-18), and Performance and Effectiveness (Questions 18-24)—reveals insightful trends, as can be seen in Table 1.

TABLE I. User experience distributed by dimension.

Dimension	Mean	Std	25th Percentile	Median	75th Percentile
Content Organisation	4,14	0,83	3,83	4	5
Navigation	4,15	0,86	4	4	5
Interface	4,3	0,78	4	4,41	5
Performance & effectiveness	4,19	0,84	3,83	4	5

The methodology [27]for evaluating whole system usability quantitatively assigns merits to Likert scale responses for questions within four usability categories. The scale and corresponding merits are: "Strongly Agree" with a merit of 1.00, "Agree" with a merit of 0.75, "Fair" with a merit of 0.50, "Disagree" with a merit of 0.25, and "Strongly Disagree" with a merit of 0.00. These assigned merits are then aggregated for each category, with the mean merit value representing the usability score for that category. The overall usability score is the average of these category-specific scores, translating into a usability level that offers a qualitative insight into the system's usability. The usability level classification correlates numeric points (0 to 1) with usability levels: "Bad" (0-0.2), "Poor" (0.2-0.4), "Moderate" (0.4-0.6), "Good" (0.6-0.8), and "Excellent" (0.8-1.0). This structured approach facilitates analysis and interpretation of user feedback, converting quantitative data into actionable insights for system improvement.

As shown in Table 2, Overall, Interface and Performance and Effectiveness is perceived most favorably with an average merit of 82,98% and 80,30% respectively, and an Excelent usability level. Meanwhile, Content Organisation and Navigation lag slightly behind with an evaluation of 78,80% and 78,83% respectively, an usability level of Good . It is also relevant to note that the "good" rating is at the upper limit. These results highlight the critical areas for enhancement and the overall positive perception across the students from different contexts.

TABLE II. GENERAL USABILITY REPORT.

Dimension	Merits	Usability level
Content Organisation	78,80%	Good
Navigation	78,83%	Good
Interface	82,98%	Excellent
Performance and effectiveness	80,30%	Excellent

VII. CONCLUSIONS

The application of the user experience instrument played a fundamental role in the pilot test. It served as a tool to gather feedback on simulator usage activities. The instrument enabled the collection of structured data, allowing the research team to assess user satisfaction, identify weaknesses, and refine the simulator design iteratively.

The iterative development process of the pilot test was essential to improve the effectiveness and usability of the Virtual Logistics simulator. Based on the feedback and insights gathered during the pilot sessions, the simulator underwent significant improvements, addressing identified issues and incorporating suggested changes. These improvements were aimed at refining features, strengthening usability, and ensuring that the simulator was closely aligned with the educational needs of logistics and supply chain management. The iterative approach allowed the research team to continually refine the simulator, validating the impact of improvements through additional pilot testing. This comprehensive, user-centered design process aimed at ensuring that the Virtual Logistics simulator evolve to provide a valuable educational resource for logistics students, educators, and professionals in the field of logistics education.

The Simulation for Learning platform is a cutting-edge tool designed to significantly enhance complex thinking and self-directed learning, crucial competencies for thriving in Industry 5.0. By providing a simulation environment, it enables users from businesses, the education sector, and the workforce to develop and refine strategic decision-making and problem-solving skills autonomously. Future research will focus on assessing the platform's impact on fostering these abilities, particularly its role in facilitating strategic thinking in business contexts, enhancing continuous learning and adaptability in the workforce, and improving student engagement and critical thinking in educational settings. This research aims to underscore the platform's effectiveness in preparing individuals for the complexities of the modern workplace, ensuring they are equipped with the self-directed learning capabilities necessary to succeed in an ever-evolving technological landscape.

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REFERENCES

[1] M. Fisher, J. King, and G. Tague, “Development of a self-directed learning readiness scale for nursing education,” Nurse Educ. Today, vol. 21, no. 7, pp. 516–525, Oct. 2001, doi: 10.1054/nedt.2001.0589.

[2] Y.-Y. Wang, Y.-S. Wang, and S.-E. Jian, “Investigating the Determinants of Students’ Intention to Use Business Simulation Games,” J. Educ. Comput. Res., vol. 58, no. 2, pp. 433–458, Apr. 2020, doi: 10.1177/0735633119865047.

[3] S. Barykin et al., “Developing the physical distribution digital twin model within the trade network,” in Academy of Strategic Management Journal, Allied Business Academies, 2021, pp. 1–24. Accessed: May 06, 2023. [Online]. Available: https://riunet.upv.es/handle/10251/183983

[4] Clement, J., “Topic: Video gaming in the United States,” Statista. [Online]. Available: https://www.statista.com/topics/8739/video-gaming-in-the-united-states/

[5] M. S. Ramírez-Montoya, I. M. Castillo-Martínez, J. Sanabria-Z, and J. Miranda, “Complex Thinking in the Framework of Education 4.0 and Open Innovation—A Systematic Literature Review,” J. Open Innov. Technol. Mark. Complex., vol. 8, no. 1, Art. no. 1, Mar. 2022, doi: 10.3390/joitmc8010004.

[6] O. Chernikova, N. Heitzmann, M. Stadler, D. Holzberger, T. Seidel, and F. Fischer, “Simulation-Based Learning in Higher Education: A Meta-Analysis,” Rev. Educ. Res., vol. 90, no. 4, pp. 499–541, Aug. 2020, doi: 10.3102/0034654320933544.

[7] Z. Zhan, Y. Tong, X. Lan, and B. Zhong, “A systematic literature review of game-based learning in Artificial Intelligence education,” Interact. Learn. Environ., vol. 0, no. 0, pp. 1–22, 2022, doi: 10.1080/10494820.2022.2115077.

[8] L. Nadolny, A. Valai, N. J. Cherrez, D. Elrick, A. Lovett, and M. Nowatzke, “Examining the characteristics of game-based learning: A content analysis and design framework,” Comput. Educ., vol. 156, p. 103936, Oct. 2020, doi: 10.1016/j.compedu.2020.103936.

[9] S. S. Oyelere, N. Bouali, R. Kaliisa, G. Obaido, A. A. Yunusa, and E. R. Jimoh, “Exploring the trends of educational virtual reality games: a systematic review of empirical studies,” Smart Learn. Environ., vol. 7, no. 1, p. 31, Oct. 2020, doi: 10.1186/s40561-020-00142-7.

[10] C. Udeozor, R. Toyoda, F. Russo Abegão, and J. Glassey, "Digital games in engineering education: systematic review and future trends," Eur. J. Eng. Educ., vol. 48, no. 2, pp. 321–339, Mar. 2023, doi: 10.1080/03043797.2022.2093168.

[11] A. Patiño, M. S. Ramírez-Montoya, and G. Ibarra-Vazquez, "Trends and research outcomes of technology-based interventions for complex thinking development in higher education: A review of scientific publications," Contemp. Educ. Technol., vol. 15, no. 4, p. ep447, Oct. 2023, doi: 10.30935/cedtech/13416.

[12] J. Baena-Rojas, I. Castillo-Martínez, J. Mendez-Garduño, P. Suárez-Brito, and E. López-Caudana, "Information Communication Technologies, Artificial Intelligence, and Social Robotics: A Complex-Thinking Vector in Higher Education?," J. Soc. Stud. Educ. Res., vol. 14, no. 2, pp. 21–50, Jun. 2023.

[13] P. Ponce, R. Ramirez, M. S. Ramirez, A. Molina, B. MacCleery, and M. Ascanio, "From understanding a simple DC motor to developing an electric vehicle AI controller rapid prototype using MATLAB-Simulink, real-time simulation and complex thinking," Front. Educ., vol. 7, 2022, Accessed: Apr. 27, 2023. [Online]. Available: https://www.frontiersin.org/articles/10.3389/feduc.2022.941972

[14] A. B. Hernández-Lara, E. Serradell-López, and À. Fitó-Bertran, "Students' perception of the impact of competences on learning: An analysis with business simulations," Comput. Hum. Behav., vol. 101, pp. 311–319, Dec. 2019, doi: 10.1016/j.chb.2019.07.023.

[15] A. Hubl and G. Fischer, "Simulation-Based Business Game for Teaching Methods in Logistics and Production," in 2017 Winter Simulation Conference (wsc), V. Chan, A. DAmbrogio, G. Zacharewicz, and N. Mustafee, Eds., New York: Ieee, 2017, pp. 4228–4239. Accessed: Apr. 19, 2023. [Online]. Available: https://www.webofscience.com/wos/woscc/full-record/WOS:000427768604039

[16] G. Biswas et al., "Multilevel Learner Modeling in Training Environments for Complex Decision Making," IEEE Trans. Learn. Technol., vol. 13, no. 1, pp. 172–185, 2020, doi: 10.1109/TLT.2019.2923352.

[17] D. Rumeser and M. Emsley, "Can Serious Games Improve Project Management Decision Making Under Complexity?," Proj. Manag. J., vol. 50, no. 1, pp. 23–39, 2019, doi: 10.1177/8756972818808982.

[18] A. M. Law, W. D. Kelton, and W. D. Kelton, Simulation modeling and analysis, vol. 3. Mcgraw-hill New York, 2007. Accessed: Feb. 15, 2024. [Online]. Available: http://ndl.ethernet.edu.et/bitstream/123456789/87806/5/Simulation%20Modeling%20and%20Analysis%20by%20Averill%20M%20Law%20%28z-lib.org%29.pdf

[19] J. Sokolowski and C. Banks, "Principles of Modeling and Simulation: A Multidisciplinary Approach," VMASC Books, Jan. 2009, [Online]. Available: https://digitalcommons.odu.edu/vmasc_books/2

[20] M. Grieves and J. Vickers, "Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems," in Transdisciplinary Perspectives on Complex Systems, F.-J. Kahlen, S. Flumerfelt, and A. Alves, Eds., Cham: Springer International Publishing, 2017, pp. 85–113. doi: 10.1007/978-3-319-38756-7_4.

[21] J. Leng, D. Wang, W. Shen, X. Li, Q. Liu, and X. Chen, "Digital twins-based smart manufacturing system design in Industry 4.0: A review," J. Manuf. Syst., vol. 60, pp. 119–137, Jul. 2021, doi: 10.1016/j.jmsy.2021.05.011.

[22] A. Villalonga et al., "A decision-making framework for dynamic scheduling of cyber-physical production systems based on digital twins," Annu. Rev. Control, vol. 51, pp. 357–373, Jan. 2021, doi: 10.1016/j.arcontrol.2021.04.008.

[23] J. Vidakovic, M. Lazarevic, V. Kvrgic, I. Vasovic Maksimovic, and A. Rakic, "Flight Simulation Training Devices: Application, Classification, and Research," Int. J. Aeronaut. Space Sci., vol. 22, no. 4, pp. 874–885, Aug. 2021, doi: 10.1007/s42405-021-00358-y.

[24] W. H. M. Zijm, M. Klumpp, S. Heragu, and A. Regattieri, "Operations, Logistics and Supply Chain Management: Definitions and Objectives," in Operations, Logistics and Supply Chain Management, Springer, 2019, pp. 27–42. doi: 10.1007/978-3-319-92447-2_3.

[25] S.-H. Chung, "Applications of smart technologies in logistics and transport: A review," *Transp. Res. Part E Logist. Transp. Rev.*, vol. 153, p. 102455, Sep. 2021, doi: 10.1016/j.tre.2021.102455.

[26] M. Woschank and C. Pacher, "Teaching and Learning Methods in the Context of Industrial Logistics Engineering Education," Procedia Manuf., vol. 51, pp. 1709–1716, Jan. 2020, doi: 10.1016/j.promfg.2020.10.238.

[27] T. K. Chiew and S. S. Salim, "WEBUSE: Website Usability Evaluation Tool," *Malaysian Journal of Computer Science*, vol. 16, no. 1, Art. no. 1, Jun. 2003.

[28] A. Ahmed and M. Sutton, "Gamification, serious games, simulations, and immersive learning environments in knowledge management initiatives," *World Journal of Science, Technology and Sustainable Development*, vol. 14, pp. 78–83, Apr. 2017, doi: 10.1108/WJSTSD-02-2017-0005.