ISSN 1846-6168 (Print), ISSN 1848-5588 (Online)
https://doi.org/10.31803/tg-20250508113124

Preliminary communication
Received: 2025-05-08, Accepted: 2025-05-22

Perceived Helpfulness of Learning Methods for Developing Logistics Competencies in the Context of Digitalization, Sustainability, and Industry 4.0

Simona Šinko, Tone Lerher, Brigita Gajšek*

Abstract: This study explores the perceived helpfulness of addressed learning methods in developing competences essential for logistics activities, particularly those related to digitalization, sustainability, and Industry 4.0. A total of 623 respondents, including logistics students, employees, and representatives of logistics associations and leading-edge companies, rated 17 learning methods. The findings reveal a strong preference for experiential formats. Over 95% of respondents rated methods such as real-world problem-solving in companies, the use of professional software, and guided simulations helpful. In contrast, more passive methods like critical reading and independent study were perceived as less effective. Statistically significant differences between students and employees underscore the role of prior industry experience in shaping learning preferences. Survey's results highlight the value of applied learning and closer collaboration with industry in logistics education, offering actionable insights designing training programs that align with the logistics sector's evolving needs.

Keywords: competences; digitalization; Industry 4.0; learning methods; logistics; sustainability

1 INTRODUCTION

Logistics is managing material, and information flows within businesses to ensure that goods are delivered to the end customer in the most efficient and cost-effective manner. It involves the movement, storage, and handling of materials, along with the management of related information. As a fundamental component of the global supply chain, logistics ensures the coordinated and timely movement of goods and materials across suppliers, manufacturers, and consumers by managing transportation, warehousing, inventory, and distribution processes. The logistics supply chain typically includes supply, production, distribution, and reverse logistics [1]. In light of growing pressures to improve sustainability, logistics also faces the challenge of reducing its carbon footprint and adopting greener practices [2].

The logistics sector is transforming rapidly, driven by Industry 4.0 technologies such as artificial intelligence, automation, and data analytics. These technologies not only optimize efficiency but also address sustainability challenges [3, 4]. As a result, logistics professionals must adapt to new needs, requiring new competencies in technology, environmental awareness, and digitalization [5, 6].

Existing literature primarily addresses traditional logistics skills, such as transportation and inventory management, while overlooking the need for expertise in Industry 4.0, sustainability, and digitalization [7]. As part of a broader research agenda on the evolving competency requirements in logistics, this study specifically examines which learning methods most effectively support students in acquiring the skills necessary to navigate the challenges of digitalization, sustainability, and Industry 4.0.

Effective logistics practice requires both specialized knowledge and practical skills. While formal education provides a basic knowledge, hands-on experience and continuous learning are beneficial for progress in this rapidly changing field [8]. Lifelong learning, both formal and informal, is needed for professional growth and organizational success. Training programs should combine theoretical knowledge with practical application, leveraging case studies, simulations, and industry partnerships, to ensure that professionals can effectively transfer their learning in real-world practice [9].

The research by Stevens et al. [10] and Kozma [11] emphasizes the importance of collaboration between educators and students to ensure that learning outcomes are achieved, whether through in-person or online learning modalities. Online learning, in particular, has been found to provide greater flexibility and opportunities for collaboration, fostering higher cognitive engagement and enhancing knowledge retention [12]. A blended approach may be essential for equipping logistics professionals with the diverse skill set required in an increasingly digital and sustainable industry.

This paper addresses a gap in existing research by exploring how different stakeholder groups perceive the effectiveness of seventeen purposefully selected learning methods in fostering the competencies needed in modern logistics, necessary to navigate the challenges of digitalization, sustainability, and Industry 4.0. Three stakeholder groups were defined, namely full-time students, logistics employees, and representatives of leading-edge companies and logistics associations. Based on a large sample, this study provides insights into opportunities to improve logistics education and training.

Despite increasing focus to sustainability, digitalization, and Industry 4.0 in logistics, there remains limited understanding of which learning methods are most effective in preparing students to implement related activities. Existing educational programs often rely on traditional instructional formats, which may not align with the sector's evolving needs. This gap motivated the present study, which seeks to identify how different stakeholder groups perceive the effectiveness of addressed learning methods in developing relevant logistics capabilities.

Building on previously defined stakeholder groups, this research explores how perceptions regarding the effectiveness of learning methods differ among full-time students, logistics employees, logistics pioneers in Industry 4.0, digitalization and sustainability, and representatives of

national logistics associations, with a focus on preparation for real-world logistics challenges. This study provides actionable insights to help industry and educational institutions design more targeted training programs tailored to the future needs of the logistics industry.

The paper continues with an overview of the research methodology, followed by the presentation of results that identify key activities and skills essential for addressing the challenges posed by Industry 4.0, sustainability, and digitalization. It highlights the learning methods considered most effective for acquiring practical knowledge, based on insights from both educators and industry experts. The discussion section offers recommendations for enhancing logistics education, while the conclusion summarises key findings and proposes directions for future research.

2 METHODOLOGY

The methodological approach builds on four interconnected research stages, combining conceptual groundwork and empirical validations to:

- determine learning outcomes relevant for logistics higher education on sustainability and Industry 4.0;
- determine competences that logistics personel shoul have to cope with challenges of introducing new technologies and EU guidelines;
- access readiness of logistics personel to logistics industry because of digital transformation, development towards Industry 4.0 and introducing sustainable practices;
- examine perceived helpfulness of learning methods for developing logistics competences.

An overview of the key research stages and their respective outcomes is presented in Fig. 1. This paper focuses on the results of the final, fourth research phase.

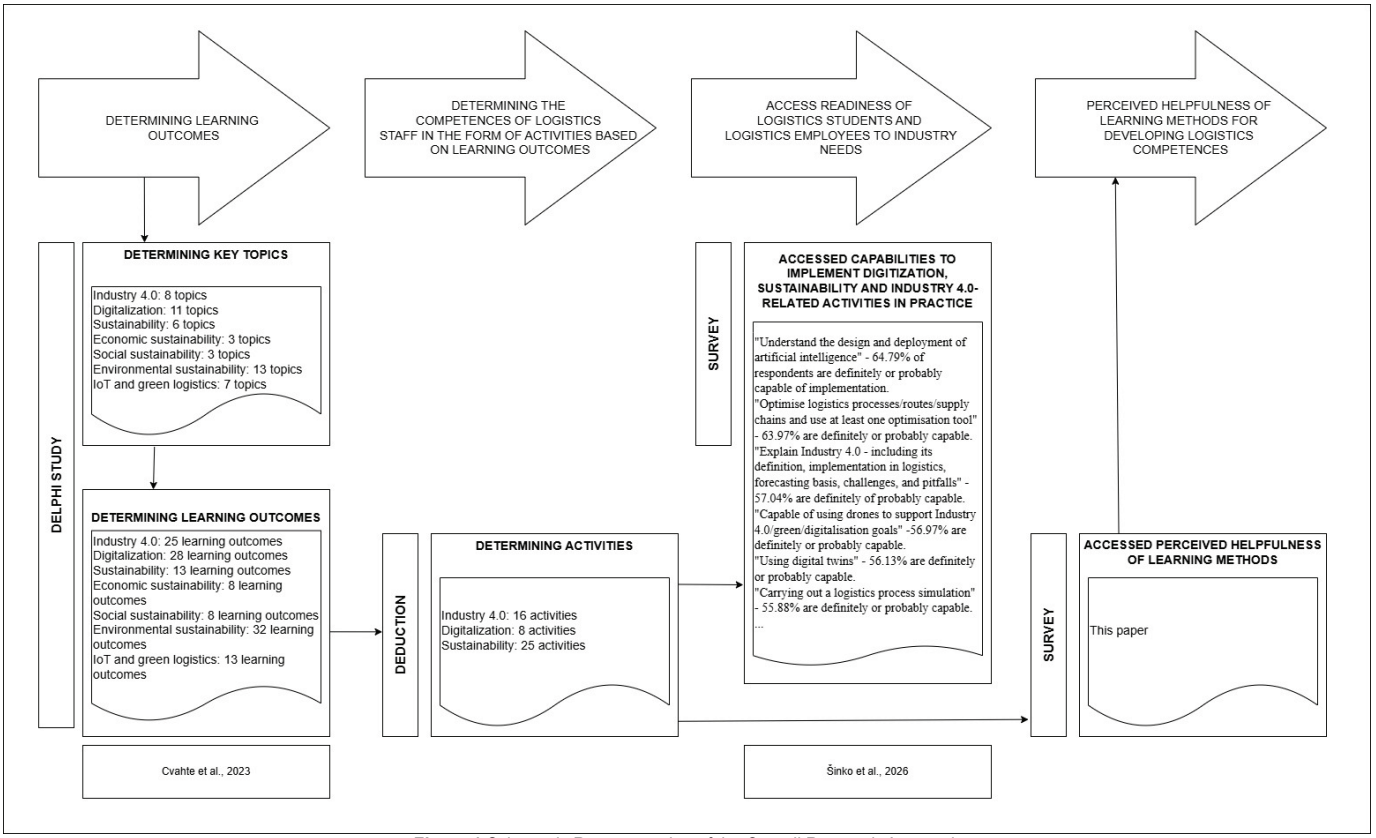


Figure 1 Schematic Representation of the Overall Research Approach

2.1 Research Design

The research process began with determining learning outcomes relevant for logistics higher education on sustainability and Industry 4.0 with the help of Delphi study. The group of competent stakeholders first determined key topics on Industry 4.0, digitalization, Sustainability, IoT and Green, for which they expect to shape the future of logistics work. Based on these topics, an initial list of learning outcomes was generated, reviewed, and iteratively refined.

All further research phases, including the fourth phase discussed in this paper, build on insights from Delphi study results described in [7], which identified 127 unique learning outcomes mandatory for logistics personnel in the context of Industry 4.0, digitalization, and sustainability. These learning outcomes were determined by an international group of experts from six countries. The panel included academics with at least two high-profile publications and company representatives from commercially successful logistics firms.

The following section presents the research design for the fourth phase of the study, which aims to investigate the

perceived effectiveness of learning methods in the development of logistics competencies. To enhance respondents' understanding of the learning outcomes in the survey, the initial list of 127 learning outcomes was systematically reviewed. For each outcome, potential activities that logistics personnel could implement in practice, particularly in the context of Industry 4.0 and digitalization, were identified and considered. The team of four academics and industry representative clustered learning outcomes according to their affiliation to management and implementation of logistics activities. The list of learning outcomes was thus converted into a list of logistical activities. Both academic and industry experts validated the final list of 49 logistics-related activities to ensure conceptual clarity, practical relevance, and alignment with real-world logistics applications.

Based on those 49 logistics-related activities, a survey questionnaire was developed. A detailed description of the questionnaire and its structure is provided in Section 2.4. The questionnaire served as a data collection mechanism for the two thematically related but independently conducted studies. The first part of questionnaire focused on assessing the readiness of logistics students and employees to meet emerging industry needs. The results are presented in [13]. The second part of questionnaire focused on researching how different respondent groups perceive their capability to perform offered logistics activities and assesses the perceived helpfulness of offered learning methods in fostering the development of those capabilities.

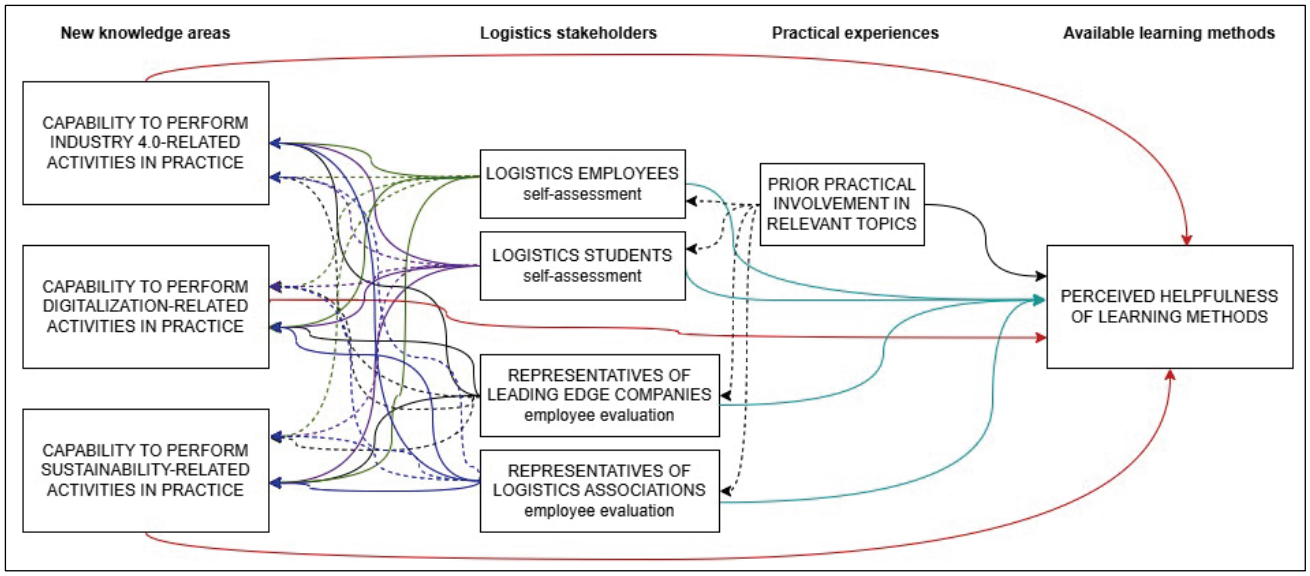


Figure 2 Conceptual Framework Showing Relationships among Key Variables in the Study

2.2 Conceptual Framework of the Research

The conceptual framework of the research is presented in Fig. 2. It presents the researched connections between logistics stakeholders, knowledge areas and learning methods. Presented framework served as a basis for developing the survey instrument and guided the subsequent statistical analysis.

The framework is structured around three main capability domains: the capability to perform Industry 4.0-related, digitization-related, and sustainability-related logistics activities. The framework is organized around three primary capability domains: the ability to perform logistics activities related to Industry 4.0, digitalization, and sustainability. These domains represent essential knowledge areas in contemporary logistics practice. The inclusion of these capabilities aimed to assess their prevalence across different stakeholder groups and to explore potential factors influencing their development.

To capture different perspectives, the framework includes self-assessment of capabilities by logistics employees and students and external evaluations provided by representatives of leading-edge companies and logistics associations regarding the capabilities of the logistics professionals currently active in the field.

In addition, the framework incorporates prior practical involvement in relevant topics, intended to explore whether such experiences are associated with higher capability levels or influence the perceived effectiveness of different learning methods.

Finally, the framework incorporates the perceived helpfulness of learning methods, reflecting how various educational approaches are evaluated in terms of their contribution to developing the specified capabilities. While not the central focus of the study, this variable plays a significant role in linking educational practices with the practical competence of logistics professionals.

2.3 Survey Instrument

The questionnaire was divided into two main sections. The first section assessed respondents' self-reported capabilities in implementing the identified activities in real-world settings. The analysis of this section was presented in prior research [13], which focused on comparing the readiness of students and logistics employees to engage with

digitalization, sustainability, and Industry 4.0-related activities.

The second section of the questionnaire explored respondents' perceptions of the helpfulness of various learning methods in developing the competencies needed to carry out the listed logistics activities. Students and logistics employees were asked: *"How would the following ways of acquiring knowledge help you acquire the above-listed competencies*?*"* Meanwhile, representatives of leading-edge companies and national logistics associations were asked: *"Which ways of acquiring knowledge would help acquire the above-listed competencies*?*"*

A total of 17 learning methods were evaluated using a 4-point Likert scale, ranging from 1 (definitely won't help) to 4 (definitely will help).

Prior to launching the full survey, the questionnaire underwent a two-phase validation process. In the first phase, it was reviewed by 14 validators representing various respondent profiles: three logistics students, five logistics employees, two representatives from national logistics associations, and four representatives of leading-edge companies in Industry 4.0 and sustainability. Feedback from this group informed revisions to the wording and structure of the questionnaire. In the second phase, the revised version was validated by experts from an Italian deep-tech company, who confirmed its clarity and alignment with the purpose of the research.

2.4 Sample and Data Collection

The survey targeted five respondent groups: (1) logistics students (514 respondents, 82.6%), (2) logistics employees (75 respondents, 12.1%), (3) representatives of leading-edge companies in Industry 4.0 (15 respondents, 2.5%), (4) representatives of representatives of leading-edge companies in sustainability (11 respondents, 1.8%), and (5) representatives of national logistics associations (7 respondents, 1.1%). The sample primarily included participants from Italy, Poland, Portugal, Slovenia, and Turkey. An additional 14.68% of respondents were from other European countries, including Austria, Brazil, Bulgaria, Bosnia and Herzegovina, Croatia, Czech Republic, Germany, Hungary, Netherlands, Romania, Russia, Spain, the United Kingdom, and Ukraine.

The online questionnaire was distributed using 1KA Arnes, a Slovenian platform for survey creation and data collection. It was shared with students from various logistics faculties and employees from logistics companies to ensure broad representation. Respondents representing leading-edge companies in Industry 4.0 and sustainability were carefully selected based on their companies' recognized excellence, with a focus on targeting middle or senior management. Heads of national logistics associations were also included to capture insights from a strategic logistics perspective. All respondents were anonymous, compliant with GDPR regulations, and used exclusively for research purposes. In total, 623 valid responses were collected, yielding a response rate of 38.9%.

2.5 Data Analysis and Availability

Data were analysed using IBM SPSS Statistics (29.0.0.0). Descriptive statistics were applied to summarise the responses, and comparisons between groups were conducted to identify trends in the perceived helpfulness of different learning methods.

The results are presented in the third section, with tables included where they are essential for clarity. For full transparency, all raw data and supplementary materials, including detailed analysis outputs, are available via the open-access link: https://osf.io/gx8az/?view_only=d877ce2fea47433fad3998546cbb8c97.

3 RESULTS

3.1 Approaches to Acquiring Knowledge for Competency Development

Tab. 1 presents respondents' perceptions of the helpfulness of various learning methods in acquiring the competencies needed to implement logistics activities related to Industry 4.0, digitalization, and sustainability. Only valid responses are included, excluding "unable to respond" entries.

The method most frequently rated as the most helpful for acquiring knowledge was the *"Study of a real problem in a real company"*, with over 70% of respondents indicating it would definitely help, and an additional 25% rating it as probably helpful. This was followed by *"Performing tasks with software that is widely used in the work environment"* (93.88% of respondents rated it as probably or definitely helpful, *"Use of video materials"* (93.81%), and *"Practical implementation of complex tasks under guidance"* (93.67%). Similarly, *"Guided use of a simulation tool"* (92.89%) and *"Listening to experts from business or professional practice on a specific topic"* (91.83%) were also perceived as highly helpful.

Other methods evaluated as helpful by more than 90% of respondents include *"Team Working with other learners in a course"* (91.27%), *"Face-to-face teaching"* (90.50%), *"Group discussion about a real problem"* (90.43%), and *"Study of a case in a laboratory"* (90.26%).

In contrast, more traditional methods were considered less helpful by a larger proportion of respondents. *"Critical reading and writing as preparation for lectures"*, *"Role-playing"*, and *"Working independently of other learners in a course"* were rated as less helpful by a significant share of participants. Nearly one-quarter of respondents felt that both *critical reading and writing* and *independent work* would probably or definitely not contribute to acquiring relevant knowledge. Additionally, *"Distance learning from home with the help of an online classroom containing materials and pre-recorded lectures"* was deemed less beneficial by 19.8% of respondents, who indicated it would not contribute to acquiring the needed knowledge.

Overall, the findings strongly favor applied, hands-on learning that emphasizes engagement with real-world challenges and expert insights. While traditional classroom-based approaches are still regarded as useful, they are

considered less effective than experiential learning in developing the relevant logistics competencies.

Table 1 Respondents' perceived helpfulness of learning methods

Learning method	1 Definitely won't help (%)	2 Probably won't help (%)	3 Probably will help (%)	4 Definitely will help (%)
Distance learning, online classroom containing materials and pre-recorded lectures	7.18	12.62	44.31	35.89
Lectures with presentations on theoretical knowledge	3.68	9.80	45.34	41.18
Critical reading	5.56	19.44	52.02	22.98
Listening to experts from business/practice on a specific topic	1.73	6.44	29.95	61.88
Group discussion about a real problem	1.51	8.06	35.52	54.91
Use of games for teaching and learning	3.04	9.62	39.75	47.59
Use of video materials	0.99	5.20	45.54	48.27
Role playing	6.91	17.14	41.94	34.02
Practical implementation of complex tasks under the guidance	2.03	4.30	36.71	56.96
Guided use of simulation tool	1.52	5.58	38.83	54.06
Performing tasks with software that is widely used in the practice	1.79	4.34	35.46	58.42
Work on a fictional case study in the classroom	3.07	7.42	45.27	44.25
Study of a case in a laboratory	2.56	7.18	41.79	48.46
Study of a real problem in a real company	0.74	3.72	25.06	70.47
Team Working with other learners in a course	2.49	6.23	42.14	49.13
Work independently of other learners in a course	4.03	19.14	46.60	30.23
Face to face teaching	4.50	5.00	43.25	47.25

3.2 Perception Differences of Learning Methods across Respondent Profiles

Tab. 2 summarizes statistically significant differences ($p < 0.05$) between students, logistics employees, and representatives from leading-edge companies and national logistics associations, as determined by Mann-Whitney U test.

Overall, logistics employees and representatives of leading-edge companies and national logistics associations perceived the learning methods as more helpful for acquiring knowledge compared to students. A statistically significant difference emerged only for the method *"Distance learning, from home with the help of an online classroom containing materials and pre-recorded lectures"*. No significant differences were found among the remaining 16 activities.

Table 2 Statistically significant differences in perceived helpfulness of learning methods across respondent profiles

Learning method	The statistically significant difference expressed with mean ranks	Mann-Whitney U test
Distance learning, from home with help of an online classroom containing materials and pre-recorded lectures	Employees (221.15) - Students (186.30)	7572.50*
Group discussion about a real problem	Employees (31.46) – RLEC Sustainability (44.00)	316.00*
	RNLA (4.83) - RLEC (9.50)	40.00*
	RLEC Industry 4.0 (6.33) – RLEC Sustainability (12.00)	60.00*
	RLEC Sustainability (236.50) - Student (161.15)	680.00*
Performing tasks with software that is widely used in the work environment	Employees (30.79) - RLEC Sustainability (44.50)	320.00*
	RLEC Sustainability (226.50) - Student (159.33)	728.00*
	RNLA (4.83) - RLEC Sustainability (9.5)	40.00*
Practical implementation of complex tasks under the guidance	RNLA (4.00) – RLEC Sustainability (8.29)	30.00*
	RNLA (82.30) - Student (162.75)	1,188.50*
Team Working with other learners in a course	RLEC Sustainability (231.00) - Student (163.36)	756,00*
Face to face teaching	RNLA (95.83) - Student (165.78)	1,378.00*

RLEC - representatives from leading-edge companies; RNLA - representative of national logistics associations; *The significance level is 0.05

Logistics employees differed from representatives of leading-edge companies and national logistics associations in their evaluations of three methods, rating them as less helpful: *"Group discussion about a real problem"*, *"Representative of an outstanding example of sustainability implementation"*, and *"Performing tasks with software that is widely used in the work environment"*.

Differences between students and representatives of leading-edge companies and national logistics associations were observed in the evaluation of five learning methods. Students rated *"Face-to-face teaching"* and *"Practical implementation of complex tasks under guidance"*. As more helpful than another group did. In contrast, representatives of leading-edge companies and national logistics associations rated the following learning methods as more helpful: *"Group discussion about a real problem"*, *"Performing tasks with software that is widely used in the work environment"*, and *"Team Working with other learners in a course"*.

4 DISCUSSION

The study's findings reveal a clear preference for experiential and practice-oriented learning methods, which were perceived as more helpful by a larger share of respondents compared to traditional learning methods, such as independent study or critical reading. This preference aligns a growing body of literature emphasising the value of hands-on learning in developing the competencies and skills

necessary for real-world logistics tasks. As Fabbe-Costes [14] notes, collaboration between academia and industry remains a key success factor in advancing logistics knowledge. Notably, this insight was already highlighted in 2012 [15], yet the present findings indicate that its integration into educational practices still requires further reinforcement.

The positive evaluation of approaches such as group discussions on real-world problems and the use of widely adopted logistics software reinforces this perspective. Both learning methods promote active engagement with practical challenges and help bridge the gap between theoretical instruction and professional practice.

The preference for practical learning is further supported by Chernikova et al. [16], who highlight simulations as effective pedagogical tools for fostering problem-solving skills. In the context of logistics, gamified modelling and simulation frameworks are especially valuable, as they contribute to the optimization of real-world logistics processes and the advancement of planning methodologies [17]. Simulation games not only enhance learning in higher education but also serve as effective tools in workplace training—improving decision-making and providing a dynamic, systems-level understanding of logistics operations [18].

Furthermore, the results suggest that respondents' evaluations of learning methods may be shaped by their personal learning preferences and prior experiences. Notable differences were observed between the perceptions of students and representatives of leading-edge companies and national logistics associations. Students generally rated learning methods such as distance learning and group discussions lower than logistics employees. A plausible explanation for this trend is students' limited exposure to real-world logistics environments, which may lead them to underestimate the relevance of methods designed to simulate or address practical challenges.

Another contributing factor may stem from traditional educational experiences, which often emphasize passive learning. As a result, students may feel unfamiliar or even uncomfortable with more interactive learning methods. Differences in perception could also be attributed to varying levels of familiarity with specific learning methods, such as online learning or group collaboration. For instance, students may have had limited exposure to well-structured digital learning environments or collaborative group work settings, which could influence their evaluations. Additionally, perceived self-efficacy in engaging with collaborative tasks may also play a role. However, these hypotheses require further empirical investigation to better understand their impact on the perceived helpfulness of learning methods.

These findings align with the broader literature, which suggests that traditional classroom methods often lack the practical applications necessary for students to effectively address real-world logistics challenges [19, 20]. Independent study tends to engage students less than experiential learning approaches. Research has shown that game-based learning and simulations are more effective in engaging students by offering interactive, real-world scenarios [21]. In contrast, traditional methods such as critical reading do not sufficiently foster key soft skills, like communication, problem-solving, and teamwork, that are better cultivated through collaborative learning environments [22].

Additionally, students tend to favour methods that incorporate technology and real-life applications, such as logistics simulation tools and learning factories, as these approaches closely mirror real-world logistics tasks [19]. While autonomous learning strategies offer theoretical benefits, they may lack the structure and guidance that some students need to develop practical skills. However, methods involving group work, leadership roles, and peer evaluation have been shown to enhance responsibility and engagement, leading to improved learning outcomes [22].

This study emphasizes the importance of integrating practical, hands-on learning experiences into logistics education. The strong preference for experiential learning, along with the observed differences in perceptions between students and logistics employees, indicates that educational programs should prioritize industry engagement, simulations, and collaborative projects. Universities could consider redesigning curricula to incorporate real-world case studies, internships, or company-based projects, while companies might focus on on-the-job training, mentoring, and guided simulations. Aligning training formats with these preferences will not only enhance the relevance of competency development but also strengthen the link between academia and industry, effectively bridging the gap between theory and practice.

5 CONCLUSION

This study explored how addressed learning methods are perceived in terms of their effectiveness in developing competencies in logistics, with particular focus on digitalization, sustainability, and Industry 4.0.

5.1 Theoretical Contribution

The findings highlight the increasing significance of experiential learning in logistics education. As the sector continues to evolve rapidly, traditional, theory-based models are no longer productive. Competence in logistics now requires not only a solid foundation of theoretical knowledge but also the ability to apply that knowledge in real-world contexts. This study contributes to a deeper understanding of how applied learning approaches support professional readiness in this dynamic field.

5.2 Practical Implications

The study provides clear guidance for education providers and industry stakeholders: move beyond traditional theory and incorporate hands-on training. Practical learning formats, such as simulations, workshops, and collaborative projects, should be embedded into both academic curricula and corporate training programs.

As logistics continues to evolve under the pressures of digitalization, sustainability imperatives, and the rise of Industry 4.0, education systems must move beyond incremental improvements and embrace a fundamental shift in how learning is designed, delivered, and integrated with industry. Future logistics education should not only respond

to current trends but anticipate them by fostering proactive, adaptive, and innovation-driven professionals. This requires embedding learning directly within operational contexts and utilizing advanced technologies, such as AI-powered simulators, digital twins, and immersive virtual environments, to replicate the complexity of real-world logistics challenges.

Furthermore, collaboration between academia and industry must become systemic rather than an incidental part of logistics education. Joint curricula development, co-supervised projects, and long-term partnerships will ensure that educational content evolves in alignment with real-world demands. Education providers should strive to create living laboratories—ecosystems where students, educators, and industry partners co-create knowledge, test innovations, and tackle authentic logistics challenges. To fully realize this vision, educational policy must support flexible, modular, and personalized learning pathways, along with stronger incentives for lifelong learning. By rethinking traditional boundaries between classroom and workplace, theory and practice, and student and practitioner, the logistics sector can cultivate a future-ready workforce capable of adapting to and leading in an evolving industry world.

5.3 Limitations and Future Research Directions

While this study provides valuable insights, several limitations should be acknowledged. The sample is predominantly composed of students, whose responses may reflect educational experiences more than practical industry realities. Although the large number of student responses increases statistical power, it may introduce sampling bias and skew the results toward academic rather than practical perspectives. Furthermore, the geographical scope of primarily covering six European countries may limit the generalisability of findings to regions with different educational systems or different technological maturity.

Another limitation lies in the reliance on self-reported data, which introduces potential bias, as respondents may not always accurately assess the helpfulness of specific methods. Emotions, limited experience with certain learning methods, or personal preferences could influence respondents' evaluations.

Future research should consider more balanced sampling across respondent profiles, using stratified or quota-based approaches. In addition, integrating objective performance-based assessments, such as simulations, task completion, or real-world problem-solving, could provide a more accurate picture of the actual effectiveness of learning methods. Longitudinal studies would further clarify how specific learning approaches contribute to competence development over time.

Finally, combining quantitative surveys with qualitative approaches, such as interviews or focus groups, may yield more profound insights into why specific learning methods are perceived as more or less helpful and how context influences these perceptions. Further investigation into the relative effectiveness of online versus in-person learning, particularly in relation to technical and soft skills, could also support the development of more tailored educational strategies.

Acknowledgements

This research was funded by the Erasmus+ project Sustainable Logistics 4.0: Digital and green skills for boosting innovation and sustainability of the logistics sector [Slog4.0].

6 REFERENCES

[1] Dey, A., LaGuardia, P., & M. Srinivasan, M. (2011). Building sustainability in logistics operations: a research agenda. *Manag. Res. Rev*., *34*(11), 1237–1259. https://doi.org/10.1108/01409171111178774

[2] Montreuil, B. (2011). Toward a Physical Internet: meeting the global logistics sustainability grand challenge. *Logist. Res*. 3, 71–87.

[3] Gammelgaard, B. (2019). Editorial: Congratulations to IJLM on its first 30 years. *Int. J. Logist. Manag., 30*(1), 2–7. https://doi.org/10.1108/IJLM-02-2019-348

[4] Winkelhaus S., & Grosse, E. H. (2020). Logistics 4.0: a systematic review towards a new logistics system. *Int. J. Prod. Res*., *58*(1), 18–43. https://doi.org/10.1080/00207543.2019.1612964

[5] Matt, D. T., & Zsifkovits, H. E. (2021). *Industry 4.0 for SMEs: Challenges, opportunities and requirements*. Switzerland: Springer Nature: Cham.

[6] Bag, S., Gupta, S., Kumar, A., & Sivarajah, U. (2021). An integrated artificial intelligence framework for knowledge creation and B2B marketing rational decision making for improving firm performance. *Ind. Mark. Manag*., *92*, 178–189. https://doi.org/10.1016/j.indmarman.2020.12.001

[7] Cvahte Ojsteršek, T., Šinko, S., & Gajšek, B. (2023). Determining learning outcomes relevant for logistics higher education on sustainability and Industry 4.0. *Teh. Glas*., *17*(3), 447–454, 2023. https://doi.org/10.31803/tg-20230505103326

[8] Thai, V. V., Tran, D. M., Nguyen, L. T. N., Nguyen, T. K., & Nguyen, T.-T. (2024). Revisiting the Role of Supply Chain Managerial Competence in Firm Logistics Performance: Do Experience and Education Matter? *Sustainability*, *16*(23), 10459. https://doi.org/10.3390/su162310459

[9] Becker, C., Rager, R. C., & Wright, F. E. (2013). Update on Validity of Required Competencies for Worksite Health Professionals. *Am. J. Health Educ*., *44*(2), 67–73. https://doi.org/10.1080/19325037.2013.764236

[10] Stevens, G. J., Bienz, T., Wali, N., Condie, J., & Schismenos, S. (2021). Online university education is the new normal: but is face-to-face better? *Interact. Technol. Smart Educ*., *18*(3), 278–297. https://doi.org/10.1108/ITSE-08-2020-0181

[11] Kozma, R. B. (1994). Will media influence learning? Reframing the debate. *ETR&D*, *42*, 7–19. https://doi.org/10.1007/BF02299087

[12] Nguyen, T. (2015). The Effectiveness of Online Learning: Beyond No Significant Difference and Future Horizons, *MERLOT Journal of online learning and teaching*, *11*(2), 309-319.

[13] Šinko, S., Mrugalska, B., & Gajšek, B. (2026). Readiness of Students and Employees in Logistics to Implement Digitization, Sustainability and Industry 4.0 in Practice. In *Sustainable innovations and performance of organizations in the age of digitalization*, S. Umair, U. Waqas, and B. Mrugalska, Eds., in Industrial and systems engineering series. Taylor & Francis Group.

[14] Fabbe-Costes, N. (2018). Logistics knowledge creation in joint industry-academia research projects: the importance of

dialogue and co-construction. *Knowl. Manag. Res. Pract.*, *16*(4), 464–476. https://doi.org/10.1080/14778238.2018.1486788
[15] Thai, V. V. (2012). Competency requirements for professionals in logistics and supply chain management. *Int. J. Logist. Res. Appl*., *15*(2), 109–126. https://doi.org/10.1080/13675567.2012.694859
[16] Chernikova, O., Heitzmann, N., Fink, M. C., Timothy, V., Seidel, T., Fischer, F., & DFG Research group COSIMA. (2020). Facilitating diagnostic competences in higher education—a meta-analysis in medical and teacher education. *Educational Psychology Review*, *32*, 157-196. https://doi.org/10.1007/s10648-019-09492-2
[17] Hubl, A., & Fischer, G. (201). Simulation-based business game for teaching methods in logistics and production. In 2017 *Winter Simulation Conference* (WSC), Las Vegas, NV: IEEE, 4228–4239. https://doi.org/10.1109/WSC.2017.8248129
[18] Jiang, P., Wang, Y., Liu, C., Hu, Y.-C., & Xie, J. (2020). Evaluating Critical Factors Influencing the Reliability of Emergency Logistics Systems Using Multiple-Attribute Decision Making. *Symmetry*, *12*(7), 1115. https://doi.org/10.3390/sym12071115
[19] Fu, H. (2017). Integration of Logistics Simulation Technology and Logistics Learning Factory in a Two-stage Teaching Method for Logistics Management Courses. *Int. J. Emerg. Technol. Learn. IJET*, 12(09), 62. https://doi.org/10.3991/ijet.v12i09.7485
[20] Schinckus, C., & Nguyen, T. T. (2022). Implementation of a real-life educational method for logistics in Vietnam: between Episteme and Techne. *Int. J. Logist. Res. Appl*., 25(11), 1469–1489. https://doi.org/10.1080/13675567.2021.1914562
[21] Pacheco-Velazquez, E., Rodés, V., & Salinas-Navarro, D. (2024). Developing learning skills through game-based learning in complex scenarios: A case in undergraduate logistics education. *J. Technol. Sci. Educ*., 14(1), 169. https://doi.org/10.3926/jotse.2219
[22] Carravilla, M. A., & Oliveira, J. F. (2004). Teaching logistics without formal classes: a case study. *Eur. J. Eng. Educ*., 29(4), 571–580. https://doi.org/10.1080/03043790410001711289

Authors' contacts:

Simona Šinko, PhD, Assistant Professor
Faculty of Logistics, University of Logistics,
Mariborska cesta 7, 3000 Celje, Slovenia
simona.sinko@um.si

Tone Lerher, PhD, Full Professor
Faculty of Logistics, University of Logistics,
Mariborska cesta 7, 3000 Celje, Slovenia
tone.lerher@um.si

Brigita Gajšek, PhD, Associate Professor
(Corresponding author)
Faculty of Logistics, University of Logistics,
Mariborska cesta 7, 3000 Celje, Slovenia
brigita.gajsek@um.si