XAMK BEYOND

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Digitalization

Pia Jääskeläinen & Cai Weaver (eds.)

XAMK
South-Eastern Finland
University of Applied Sciences

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1 INTRODUCTION

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In 2023, Large Language Models and Generative Artificial Intelligence entered the mainstream, transforming the higher education and research landscape. The progress in new digital technologies is seemingly being championed and demonized in equal measures by business leaders, educators, policymakers, and the general public alike. This even led to calls for a pause in AI development to allow legislators to catch up and investigate the effects of this new technology (Hekkillä, 2023). Higher education and research institutions are attempting to keep pace with the ongoing digital revolution and new trends in digitalization, yet are concerned about the rapid changes and the effects on our lives. Students have embraced the use of ChatGPT in essay assignments with open arms. At the same time, educators in academic institutions are concerned about the role that AI plays in learning and educational environments and how it might impact human learning (Gašević et al. 2023, 1).

According to a survey report for the education technology company Multiverse (2023b), 83 percent of business leaders want their future employees to have AI skills. Over two-thirds of leaders see huge business potential in harnessing AI, especially in terms of improving productivity and customer experience and creating more sophisticated business strategies. Another report from Multiverse (2023a) found that 67 percent of business leaders believe that the current higher education system is not well suited to deliver the skills required for the workforce in the future, especially in data, engineering, and technology. The survey revealed the belief that a person can gain in-demand skills in other ways than formal education. In other words, a graduation certificate does not guarantee the workplace but rather the individual's skills and know-how areas. However, these findings might be particular to the Anglo-Saxon business environment as the majority of the respondents of both surveys were based in the USA and UK.

As the articles in this issue of Xamk Beyond 2023: Digitalization reveal, higher education institutions play a vital role in providing the latest skills and knowledge required for the jobs of the future. After all, the research discussion on Artificial Intelligence has been ongoing since the 1950s and did not appear from a vacuum in 2023 (for a comprehensive review of

the academic literature on Artificial Intelligence and Business Value, see Perifanis & Kitsios 2023). Furthermore, education systems do not just enable students to learn how to use X piece of software or code in one specific programming language; they teach fundamental transferrable skills that will set them up for future employment.

Alf Rehn, the Professor of Innovation, Design, and Management at the University of Southern Denmark, was a keynote speaker at the Annual Bachelor Educators Seminar at Aalto University in October 2023. In his speech, he challenged educators to think if we want to settle for mediocrity in education since that is exactly what Generative Artificial Intelligence enables.

According to Rehn (2023), students should take advantage of their time in academic institutions and focus on developing skills and know-how they will utilize later in their careers. The human factor in harnessing the power of digitalization is key. Human creativity provides the real value in rising above this mediocrity. Rehn called this the civilized function of digitalization. With a foundation of civilized digitalization, a person can make the right ethical choices and add value to Artificial Intelligence. A good example of this would be a company in which a quantum computer, with its incredible capability to perform calculations exponentially faster than a regular computer, is utilized. The business owner has acquired the quantum computer to do those calculations, but the real question would be for the engineer to decide when to stop calculating.

Digitalization can provide much value, yet the additional value that students and academic educators should acknowledge is what human beings bring to the table. In this issue of Xamk Beyond, our authors explore a variety of different viewpoints on what opportunities and challenges digitalization sets for businesses as well as education.

In the first article, Miia Kosonen, Mervi Rajahonka, and Heli Saali discuss how to identify, measure, and overcome digital competence gaps in small and medium enterprises (SMEs). SMEs are investing resources into digitalization and improving the digital capacities of their business. This is made more difficult, however, as an organization often has digital competence gaps that slow the digital transformation of SMEs. In their work, they explore how the Digital Steps projects were designed to overcome these gaps pragmatically. The lessons learned in their research have significant implications for SMEs throughout the world.

Sami Jantunen and Timo Väliharju introduce the opportunities and potential the open-source software (OSS) has to create a basis for a new European digital industry, promoting innovations, changing markets, and increasing digital sovereignty. OSS enables businesses,

especially SMEs, to develop custom solutions, access a wide range of pre-built tools, and collaborate with the community to enhance functionality and performance. Their article introduces the Resilience and Innovation Capability with Open-Source Competence (Open MemoryLAB) project and explains how it will contribute to the strategic objectives on European, national, and regional levels.

Digitalization can facilitate the transition to the circular economy by improving knowledge, connections, and information sharing. Melina Maunula, Jani Kiviranta, and Ari Haapanen have explored how collecting data from customer data systems and project management systems of the South-Eastern Finland University of Applied Sciences (Xamk) can help to identify opportunities and problems in utilizing and developing the use of these systems in project and network management. The research shows how information systems that do not currently intentionally support circular economy reporting can be utilized for circular economy RDI network data collection and the related obstacles.

The next article focuses on utilizing digitalization to enhance student learning. In his article, Jagat Kunwar reviews the use of simulated business games as pedagogical methods as they improve learning outcomes through experiential and active learning among students. The article helps to understand facilitating factors in order to improve the learning outcomes in the classroom. This novel approach will be of interest to pedagogues and game designers alike.

Traditional education institutions and private companies provide education, training, awards, and certifications to meet the rapidly changing skills-development needs of the labor market. The focus has shifted from degrees (macro credentials) to micro credentials, which enable a more flexible and straightforward way to gain urgently needed skills. However, the micro credentials field has proliferated with different concepts, educational offerings, and understandings of certification. In June 2022, the Council of the European Union issued a Recommendation to develop a European-wide approach to micro-credentials for lifelong learning and employability. In her article, Laura Kuismala explores this topic in more detail, contributing to the current discussions on micro-credentials in higher education.

Mikhail Nemilentsev introduces the role of RDI-driven education in creating sustainable digitalization and innovative competences. His article discusses the various theoretical and practical perspectives of futures-driven digitalized competences within the Research, Development, and Innovation (RDI) practices in the applied educational context. RDI-driven competences are critical for students to learn during their studies since they will be useful in their future working lives.

In previous issues of Xamk Beyond, we have reflected on the role of this publication in presenting the latest research of the South-Eastern University of Applied Sciences – Xamk in English to the international scientific community. This issue is no different, as in our conclusion, we explore the ongoing discussions in research and professional writing in universities of applied sciences and reflect on the impact of digitalization and generative AI.

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2 DIGITALIZATION IN SMALL AND MEDIUM ENTERPRISES: LESSONS FROM THE DIGITAL STEPS PROJECTS

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ABSTRACT

Digital competences play an important role in most SMEs' success. SMEs operate on relatively small resources when digitalizing their business or exploring new opportunities. There is a lack of easy-to-adopt and efficient methods to identify, measure, and overcome the digital competence gaps of SMEs. Two Digital Steps projects (2018-2023) have developed and tested methods to assess the current level of digital competences within SMEs in the South Savo region, Finland, and targeted these gaps with training and guidance. In the most recent project, information on training needs was collected from 169 SMEs, of which 80 participants also completed a digital competence self-assessment. The project's impact has been studied through, among other methods, follow-up measurements of a self-assessment survey on digital competence. This article discusses how to identify, measure, and overcome digital competence gaps. The results

reveal that digital competences are not only about technological competences but also include contextual and social aspects. Digital Steps projects have been able to bring in "contextual digitalization," in other words, digitalization, to match the needs of SMEs by considering their business context and model.

Keywords: Digitalization, Digital Transformation, Digital Skills, Digital Competences, SMEs, Training Model, Competence Mapping

TIIVISTELMÄ

Digiosaamisella on merkittävä vaikutus useimpien pienten ja keskisuurten yritysten menestymiseen. Pk-yrityksillä on kuitenkin käytössään suhteellisen vähän resursseja liiketoimintansa digitalisointiin ja uusiin kokeiluihin. Digiosaamisen osaamiskuilujen tunnistamiseen, mittaamiseen ja kaventamiseen ei ole juurikaan tarjolla helppokäyttöisiä ja toimivia menetelmiä. Vuosina 2018–2023 toteutettiin kaksi Digiportaat-hanketta, joissa näitä menetelmiä kehitettiin ja testattiin. Näin voitiin arvioida eteläsavolaisten pk-yritysten digiosaamisen tasoa ja vastata tunnistettuihin osaamiskuiluihin koulutuksen ja sparrauksen avulla. Tuoreimmassa hankkeessa tietoa koulutustarpeista kerättiin 169 pk-yritykseltä ja digiosaamistaan arvioi tarkemmin 80 osallistujaa. Hankkeen vaikutuksia selvitettiin muun muassa toistamalla itsearviointikyselyä ja seuraamalla osallistujien digiosaamisen kehittymistä. Tässä artikkelissa tarkastelemme, kuinka digiosaamisen kuiluja voidaan tunnistaa, arvioida ja kaventaa. Tulokset osoittavat, ettei digiosaamisessa ole kyse ainoastaan teknologisista kyvykkyyksistä, vaan erilaiset tilanteet ja sosiaaliset tekijät vaikuttavat osaamisen kehittymiseen. Digiportaat-hankkeet ovat onnistuneet edistämään digitalisaatiota huomioimalla tarjonnassaan pk-yritysten erilaiset tilanteet ja liiketoimintamallit.

Avainsanat: Digitalisaatio, Liiketoiminnan digitalisaatio, Digiosaaminen, Digikyvykkyydet, Pk-yritykset, Koulutusmalli, Osaamiskartoitus

1. Introduction

Only a fraction of small and medium-sized enterprises (SMEs) have succeeded in truly integrating digital technologies into their business (European Commission, 2020; Depaoli et al., 2020). Considering that 98.9% of all companies are SMEs in the European Union (EU) (Eurostat, 2020) and digital competences play an important role in most SMEs' success (Vieru et al., 2015), it is central that SMEs are offered support and training to become competitive. SMEs whose employees have better digital competences adopt digital innovations more likely because of their understanding of the benefits of these innovations (Thorpe et al., 2006; Cohen and Levinthal, 1990). Yet SMEs operate on relatively few resources when digitalizing their business or exploring new opportunities.

It is crucial for companies to reflect on how digital competences relate to their business context, competitiveness, and performance. There have been attempts in the literature to develop maturity models describing how SMEs proceed towards deeper digitalization. However, these models typically are technocentric and do not consider the business value or human aspects of technologies (Alonso-Mendo et al., 2009; Depaoli et al., 2020). It has even been claimed that no general models can be adapted, as SMEs are all different, and there are no typical digitalization paths at all. There is a lack of easy-to-adopt measures and empirical evidence on a large scale. Respectively, we outline the following research questions: How do we 1) identify, 2) measure, and 3) overcome the competence gaps related to digitalization in SMEs? The first question focuses on choosing the best mechanisms to evaluate digital competences in SMEs, the second develops the appropriate measures for such purposes, and the third on advancing the learning of new digital skills and updating existing skills and knowledge manifested as a firm's ability and willingness to apply such knowledge in their digital business.

This study is based on the two Digital Steps projects implemented in South Savo, Finland (2018-2023). The main objective of the projects has been to assist SMEs in growing their digital business. To succeed in this objective, firstly, we had to develop and test methods to assess the current level of digital competences within SMEs. After this, the identified gaps were targeted in the projects with training and guidance provided by experts. The objective of this paper is to summarize the key results, observations, and lessons learned. Overall, the projects have reached over 400 SMEs and more than 500 participants while also being recognized as a success story by the European Commission.[1]

[1] See https://ec.europa.eu/esf/main.jsp?catId=46&langId=en&projectId=3978.

Our article is organized as follows. We start with a literature review on SMEs and digital competences. We then summarize the Digital Steps models and the key results from competence measurement within the Digital Steps 2.0 project, demonstrating how to identify the most important competences needed and how to provide training tailored to match competence gaps relevant to the business context of SMEs. Thereafter, we present and discuss the results, illustrating how digital competences have developed. We conclude by reflecting on the literature and proposing some implications for SMEs, development projects, and education.

2. Digital Competences in SMEs

Digital transformation can be described as the use of digital technologies to profoundly raise the company's performance (Bekkhus, 2016). It has been claimed (see Teng et al., 2022) that there are three main sources behind digital transformation in SMEs: digital transformation strategy, digital technology, and employees' digital competences. Vial (2019) describes digital transformation as a process where digital technologies create changes (disruptions), demanding companies to respond strategically and modify their value creation routes while considering structural changes needed and internal barriers affecting the outcomes of this process. In this process, investing in employees' digital competences, technologies, and digital transformation strategies are key factors for SMEs that benefit digital transformation, innovation, and continuous development (Teng et al., 2022).

It has been argued that only 17% of SMEs in the European Union (EU) have succeeded in incorporating digital technologies into their business (European Commission, 2020; Depaoli et al., 2020). The lack of understanding of the potential of digitalization and the lack of employees' competences are important barriers to overcome for SMEs to obtain the benefits of digitalization (European Commission, 2022). In 2021, only 55% of SMEs in the EU reached a basic level of digital intensity, defined as the use of at least four out of 12 selected digital technologies. The vision for the ongoing Decade of digital transformation in the EU sets a goal for 90% of SMEs to reach the basic level by 2030. (Eurostat News, 2022.) It is evident that it will not be possible to reach the objective without a significant increase in support and training offered to SMEs.

It has been estimated that roughly 70% of digital transformation initiatives do not reach their targets. Tabrizi et al. (2019) list five lessons to lead the company towards success: defining the strategy, asking the customers, relying on the company's own employees who know the company and its business, recognizing the employees' fears and emphasizing that the process is an opportunity for them to upgrade their expertise, and adopting a flat organizational structure. The relevance of these issues obviously varies depending on the size

and business context of SMEs. For example, in micro-sized enterprises, it is not always appropriate to speak about strategy but rather about mindset or attitude toward organizational development. However, it is important to note that digital transformation is not just about technology; other issues besides technology are far more important (Tabrizi et al., 2019).

For a company, an essential question is which set of employee competences is the most important and relevant in the business context. Evidently, employees working in SMEs need numerous competences to be able to serve customers and succeed at their work. Currently, digital competences are important because if SMEs want to succeed in the digital business environment, they need digitally competent employees. European Digital Competence (DigComp) Framework 2.0 for Citizens, originally developed in 2013 by the European Commission, defines digital competence as "the confident, critical, and responsible use of, and engagement with, digital technologies for learning, at work, and participation in society" (European Union, 2018; Vuorikari et al., 2022).

Vieru et al. (2015, p. 4683) submit a definition of digital competence as an individual capacity using and combining three important aspects: 1) one's knowledge (i.e., know-what), 2) skills (i.e., know-how), 3) and attitudes (i.e., know-why). These aspects are associated with three competence areas, namely technological, cognitive, and social, and they are used to tackle work-related problems and build a shared knowledge base related to organizational practices and specific organizational contexts. The idea behind the definition they presented (ibid.) is that digital competences are not just about technological competences but also contextual and social aspects. Digital competences play a vital role in the success of most SMEs (Vieru et al., 2015; Hubschmid-Vierheilig et al., 2019; Teng et al., 2022). The digital competences of the employees are not just about new knowledge about the technology but more about their positive attitude towards learning to understand how to benefit from the technology when applying it in everyday working life.

Among the diverse range of categorisations for digital competences presented in the literature, Vieru et al. (2015) propose three digital competence archetypes of SME's employees: a technical expert, organizer, and campaigner. These archetypes are proposed to provide counterbalancing attributes to implement digital technologies in SMEs successfully. Digital competences are not disconnected, but to benefit from them, employees must know how to apply them for business purposes. When applying digital competences, one must think about each organization's business context and model, creating specific requirements for competences (Vieru et al., 2015; Hubschmid-Vierheilig et al., 2019).

Earlier research on learning has also distinguished single-loop and double-loop learning. Single-loop learning means adapting to existing situations, while double-loop learning

enables change by challenging the current situation. Research has shown that innovating SMEs apply double-loop learning, leading to effective information management (Chaston et al., 2001; Kang, 2007; Rajahonka and Villman, 2022).

An important concept to mention is the absorptive capacity, in other words, the ability of a company to recognize the value of the technologies and to apply them for commercial purposes (Thorpe et al., 2006; Cohen and Levinthal, 1990). SMEs whose employees have better digital competences are more likely to adopt digital innovations due to their increased understanding of the benefits of these innovations (Vieru et al., 2015.) In other words, these SMEs and their employees have a better absorptive capacity. Digital competences – as any other competences – are built step by step so that the ability to adopt new technologies builds upon existing competences.

3. Digital steps model, measures, and data collection

The Digital Steps project 2.0 model was based on defining the relevant areas of digital competences for business and the competence gaps related to these areas for each SME. In this way, only those competence areas which are relevant to the business context of the SME are discussed. The relevant competence areas having competence gaps directly correspond to the training needs of the company. This information was gathered in a meeting between a business advisor and a representative of the SME, typically a managing director. In this meeting, a digital competence mapping, i.e., a company-specific initial survey, was conducted. The competence mapping contained 48 different sub-areas to choose from, collected under nine key competence areas related to digital competences suitable for the reference framework of SMEs. Based on the survey, the training needs of the SME were defined, and a company-specific action plan with a syllabus was drafted. (See Figure 1.)

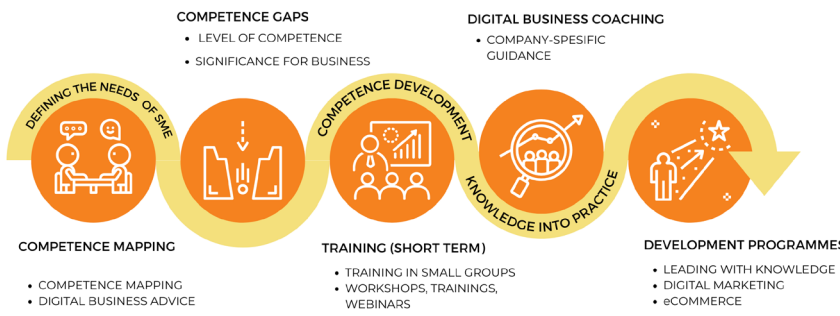

Figure 1. The operational model of the Digital Steps 2.0 project

By the end of the Digital Steps 2.0 project, 187 competence mappings have been conducted. This article discusses the competence mappings of 169 SMEs, i.e., whose data were filed by the end of May 2023. Only 15 of these SMEs were other than micro-sized enterprises (max ten employees). Of the SMEs, 99 were from Mikkeli, 35 were from Savonlinna, and the rest were from other municipalities in the South Savo region. The biggest industry was retail or wholesale (38 companies) and manufacturing (24 respondents). The average age of competence mapping participants was 47.6 years; 96 persons were less than 50 years old, and 73 were older. 111 of the respondents were women, and 58 were men.

In the Digital Steps 2.0 project, the competence mappings were gathered in the Hyviö tool. This tool has been developed for evaluating and visualizing outcomes and impacts (see Janhunen & Kosonen, 2022). Hyviö allows the constant monitoring of new training needs. According to the competence mappings, the average number of training needs for the 169 respondents was 14.9 (of 48). There were differences depending on the gender and industry: for women, the average number was 15.5, and for men, 13.9, whereas for retail or wholesale, it was 14.4, and for manufacturing, 11.3.

Each individual participant – i.e., an entrepreneur, director, or employee of an SME – was also invited to answer a simplified digital competence self-assessment test in Hyviö, which was repeated several times during the project. The test measured two dimensions: the participant's current level of digital competences and the importance of the competence areas in his or her work, which together formed the competence gaps. This test contained the same nine key competence areas as the competence mapping survey, but these areas were not divided into sub-areas. One of the most significant benefits of using Hyviö is that the advances are easy to report and visualize, and the system allows each participant to monitor the development of their own digital competences after responding to the follow-up questionnaire.

For the project's personnel, the competence mappings contained the training needs at the company level and produced information that supported the training planning best suited to the participating SMEs' needs. Hyviö can generate a report of training needs within a specific time period, making it easy to track the development of training needs. Moreover, through self-assessments, the project's personnel received information about the project's results and impact.

The project organized training based on the needs of companies. For some training subjects, training was organized at two different levels: basic and advanced. In addition to digital training, the project also provided sparring for practical work and problem-solving. Furthermore, the project organized extended training programs on digital marketing and

e-commerce, and with agricultural entrepreneurs, for example, crop mapping pilots were implemented. In the first Digital Steps project, all training was organized on-site in Mikkeli and Savonlinna, where the emphasis was on networking and learning from others. Due to the COVID-19 pandemic, training was moved online in the Digital Steps 2.0. When the situation allows, training has been organized both on-site and online. During the projects, several hundreds of entrepreneurs and their employees have participated in the projects' activities.

4. Observations and results of Digital Steps projects

In this section, we discuss, based on the results of Digital Steps projects, how to identify, measure, and overcome digital competence gaps.

4.1 Identifying competence gaps

In Digital Steps projects, the first step was to determine and select the most important digital competences for the SMEs of the South Savo region. The competence mapping of the Digital Steps project included a selection of 39 competence areas. In contrast, in the Digital Steps 2.0 project, there was a selection of 48 of the most common digital training needs in nine key competence areas. The new survey also had an open section for other training needs. These competence areas and training needs were defined with consideration of SMEs and especially service companies typical for the region. According to Vieru et al. (2015, p. 4683), digital competences do not solely refer to the technological perspective but also encompass cognitive and social aspects. The competence mapping in Digital Steps 2.0 also aimed to address various perspectives comprehensively.

Competence mappings were conducted during meetings with companies and business advisors, and the meetings were crucial parts of the process. During the competence mapping, SMEs had the chance to reflect on their areas for development, training needs, and growth opportunities while receiving valuable feedback. To simplify the process, the Digital Steps 2.0 project used an approach where not the training needs for all 48 points were defined, but only those competence areas or training needs were discussed that were relevant for each SME based on their business context and model. To guarantee this, these meetings started with discussing the company's business model with the help of a simplified business model canvas.

To confirm the results of the competence mappings of the SMEs at the employee level, a digital competence self-assessment test was also compiled to reveal the digital competence gaps of employees in terms of their own work in the company. The aim of the test was to obtain more precise information about which areas of expertise are particularly important for work and, therefore, worth prioritizing for development. The self-assessment test was also used to track the development of these competences at an individual level.

4.2 Measuring competence gaps

The results of the competence mappings and self-assessments appeared to be quite similar. Producing online content, digital advertising, and data collection emerged as the most important training needs in the competence mappings. These same areas had the widest competence gaps in self-assessments, together with online visibility.

The least common training needs were related to internal production management. Further, the smallest competence gap was found in this competence area. Table 1 lists the 10 (out of 48) most relevant training needs based on competence mappings. According to the data, for example, a total of 102 entrepreneurs or managing directors of SMEs have expressed graphic web content production as one of their training needs.

Table 1. Most common training needs measured (May 2023)

Competence area	Answers (N=169)
Producing online content: Graphic content creation	102
Digital advertising: Ad-creation	101
Digital advertising: Email marketing	98
Digital advertising: Facebook Business Manager, level II	95
Data collection, analysis, and utilisation: Google Analytics	94
Social media: Instagram	83
Digital advertising: Facebook Business Manager, level I	81
Online visibility: SEO, level I	79
Digital advertising: Google Ads, level I	77
Producing online content: Online writing	74

Table 2 shows the average size of each competence gap in percentages based on the first self-assessment tests (baseline measurement). The competence gap is presented from 0% to 100%, and the higher the result, the wider the competence gap. The widest competence gaps were found in digital advertising and online visibility, where the gap was 51% in both themes.

Table 2. Competence gaps in baseline measurements (May 2023)

Competence gap	Gap size (N=80)
Digital advertising	51%
Online visibility	51%
Data collection, analysis, and utilization	43%
Producing online content	40%
Social media	38%
Online shopping and digital sales	38%
Digital information management and information security	35%
Basic competences and work efficiency	25%
Internal production management	24%
Average	38%

The findings of both Digital Steps projects show that to meet the needs of each SME, the most relevant digital competences and gaps related to these competences must be defined based on each SME's business model, context and needs. By identifying the most relevant competence areas and the widest gaps linked to these relevant areas, an efficient syllabus can be built so that SMEs can only concentrate on studying the things that are relevant to the success of their business.

4.3 Overcoming competence gaps

After the competence mapping, the SMEs were invited to participate in the training, sparring sessions, and targeted training programs, where they could learn new digital competences and develop them further. During the training sessions and between them, the participants were encouraged to apply new knowledge into action. Sparring was particularly useful for many because the participants could implement skills under the personal guidance of an expert and receive support, advice, and feedback.

The training programs on digital marketing and e-commerce offered clear study paths toward the growth of e-commerce and a comprehensive understanding of digital marketing. However, systematic progression was easier for some while more challenging for others. Participants, for instance, joined the project at different times, making the training timing challenging. Moreover, individual interest, time constraints, and other resources also affected how systematically entrepreneurs could advance their learning.

The development of the participant's competence was monitored with self-assessment tests performed every six months. With the follow-up measurements, both the participants themselves and the project team were able to monitor the development of digital competences. Based on the results of the monitoring measurements, competence gaps decreased in all areas except for basic competences by the end of the project. In the Digital Steps 2.0 project, no training sessions were organized to develop basic competences. Still, upon closer analysis of the data, it was observed that the basic competences had improved on average during the project for these respondents. However, the perceived importance of this competence area for their own work had also increased, possibly because the significance of basic competences was now better understood than before. The most significant improvement in competencies occurred in internal production management within the company, even though it was initially considered one of the least prioritized training needs and competence gap. The next most significant improvement in competence gaps occurred in producing online content, digital information management and information security, and the corporate use of social media.

Toward the end of the Digital Steps 2.0 project, participants were asked to answer a questionnaire about operating models (Rajahonka & Saali, 2023). Based on the results, the most beneficial operations from the SMEs' perspective were competence mappings and sparring. Additionally, the overall training offering was considered nearly equally valuable. From a personal standpoint, the most effective operations highlighted were online training sessions, easily accessible practical support, and the timing of the training session in the mornings. On the other hand, peer learning and self-assessments of digital competences were not perceived as particularly effective approaches. This could be due to the difficulty of peer learning in online training sessions, and because not all participants conducted self-assessments and follow-up measurements, they also missed the opportunity to track their development of digital competences.

Based on the results, participants also adopted new tools and enhanced the use of existing tools during the project. At its best, some participants were able to directly apply what they learned into practice. On the other hand, some mentioned that the adoption of tools or new skills was still in progress, so tangible benefits had not yet emerged.

Both projects received very positive feedback from the participating SMEs. The most valued form of learning was firm-specific sparring, where business advisors and trainers provided guidance for a specific task chosen in collaboration with the participating SME. Typical tasks/objectives were related to improving customer experience in the online stores, gaining better results with the selected digital marketing channels, and the overall brand and concept, for instance. In the feedback, 90% of the participants indicated they were highly satisfied with the results and were able to put new knowledge into use themselves, with the support of advisors.

Based on the experiences the business advisors have gained in the Digital Steps projects, the industry of the SMEs is not actually a distinguishing factor in terms of learning outcomes and growing digital competences. There have been both success stories and less encouraging results from firms that represent the same industry. This perception may originate from the fact that there is no one "all-encompassing" level of digitalization that every industry should achieve; instead, objectives considering digitalization differ depending on each SME's business goals and context, including its market and customer needs, as described above.

5. Discussion

Various obstacles may hinder establishing a learning path from basic to advanced competences, such as unclear objectives, lack of time or resources, or changing conditions and unexpected events. How could business advisors and trainers overcome these challenges, then? In our view, clear objectives, focused training content, and tailored paths with well-planned schedules would support achieving better results. The best situation would be if it were possible to create Specific, Measurable, Achievable, Relevant, and Time-bound (SMART) goals with each SME. It also calls for coherence and structure: all participants must commit themselves to the selected tasks and avoid the "anything goes" type of activity.

There are major differences between SMEs who have participated in the projects, but the most differentiating factor is the time and focus dedicated to developing digital competences. Another crucial factor is attitude, motivation, and willingness to invest in digitalization and acquire related competences, such as dedicating monetary resources to online marketing or hiring staff to develop an online store. However, it is good to remember that the competences develop step-by-step and require dedication, commitment, and continuous learning to ensure that development occurs. In the case of SMEs, it is typical that great leaps are only possible to achieve with many baby steps.

Developing digital competences and aiming for the digital transformation of business is a moving target: digital competences must constantly be updated and developed further while keeping in mind the changing needs of everyday working life. This is the only way to link training to the most important competence areas for SMEs to grow and develop their business. However, as the target is moving, it is not easy to evaluate the meaning of competence gaps. An example is that the competence gap between basic competences and work efficiency has narrowed far less than some other competence gaps, but the biggest reason seems to be that the respondents have estimated the significance of this competence area in the follow-up tests as much bigger than in the baseline tests. This could be interpreted as the respondents' increased understanding of the relevance of this specific competence area.

The benefit is not only hard data but also development in other softer issues. Many participants described how they had gained more insight and self-confidence in trying out and learning new things. Further, it is difficult to evaluate how the entrepreneurs, managing directors, or their employees' attitudes have changed toward digitalization.

There are limitations in our research. At this stage, only one-fifth of those who conducted the self-assessment have completed the follow-up measurement. In addition, the response styles of participants and business advisors vary, impacting the overall results. This has reflected, for example, on the number of identified training needs in competence mappings per company, varying from the average of 13 to 20 competence areas depending on the business advisor in question.

6. Conclusions

Our paper explored the key results from Digital Steps projects. In 2018, the original project was launched to promote the digital competences of small and micro-sized enterprises, and from 2021 to 2023, the project operated under the name of Digital Steps 2.0. In both projects, the consortium partners have been the South-Eastern Finland University of Applied Sciences (Xamk), Mikkeli Development Miksei Ltd, Savonlinna Development Services Ltd, and ProAgria Southern Savo. Each project participant has had a distinct role. Xamk led the project and bore the primary responsibility for its success. The other project members have been responsible for contacting SMEs and providing practical guidance. Xamk has brought expertise in collecting data, organizing training, and disseminating results, while other organizations have had strong experience and competence in business advisory services.

The goal of the first Digital Steps project was to renew the digital education offered to SMEs in the South Savo region by creating a new competence mapping model. There was a clear need for practice-oriented tools and training to develop the digital competences of SMEs. Competence mappings enabled the offering of training based on the needs of SMEs. For competence mapping, C&Q Software solution for competence management was used. Although the experiences of using C&Q software were rather positive, the system where all the competence gaps were explored and discussed with the respondents was felt too heavy for the project's purposes. Moreover, continuous monitoring of emerging needs was not without effort. That is one reason why, in the Digital Steps 2.0 project, the competence mappings were gathered in the Hyviö tool.

By assessing SMEs' current level of proficiency, it was possible to develop a customized training program for each company based on their individual needs. SMEs have been

offered demand-driven digital training tailored to meet the specific needs of each SME. Additionally, the knowledge and skills of business advisors have enhanced to meet future demands. During the first Digital Steps project, a sparring model supporting companies' own learning was also developed. The sparring model arose from the observation that it would be useful to deepen what was learned in the training and, at the same time, turn the new knowledge into action right away. This observation was supported also by the feedback received from the participants. The operational model of the Digital Steps project was found to be practical, so in the second project, it was further developed to better meet the needs of the SMEs of the region.

6.1 Implications for SMEs

Based on the experiences gathered in the Digital Steps projects, we can corroborate the evidence presented in the literature that better digital competences become manifested as better business results. Based on training and coaching feedback, most of the participating SMEs in the project have been able to use the lessons learned directly in their own business. This is understandable because the relevant areas of digital competences and a syllabus have been defined for each SME, but also because most of the training sessions have been practice-oriented and contain concrete advice. Further, hands-on coaching related to digital tools has been offered if needed.

Earlier, we referred to the estimate that roughly 70% of digital transformation initiatives do not achieve their targets (Tabrizi *et al.,* 2019). Even though we do not have an estimation of how many of the SMEs participating in Digital Steps projects had an objective to totally transform their business with digitalization or how many succeeded, we can refer to Vieru *et al.* (2015) and Tabrizi *et al.* (2019), who explained that digital competences and transformation include contextual and social aspects, together with technological competences. In a similar vein, the Digital Steps projects have been able to achieve "contextual digitalization" - in other words, digitalization to the context of the SMEs of the region by considering the SMEs' business context and model, such as their profiles, markets, products and services, customers, industries and existing networks.

As the participants regularly highlighted, the project has helped them reach far beyond mere technological knowledge, gaining more self-confidence and establishing a mindset favoring experimenting in digital channels. This, in turn, supports the development of digital competences which are relevant to the business life of the entire region.

Neeley and Leonardi (2022) stated that two dimensions are important concerning digital transformation, namely, if people believe digital transformation is beneficial to the company and if they trust that they can learn to use digital technologies. Advancing these dimensions is of the utmost importance to ensure double-loop learning, enabling change by challenging the current situation and allowing digital transformation. Advancements do not happen overnight. Time is required for both learning and developing methods for impact evaluation.

6.2 Implications for RDI projects and education

In addition to advancing digital transformation in SMEs, our work has several implications for development projects and advocates for continuous learning in work-life. Regarding continuous learning, entrepreneurship societies in Finland have recently called for more flexible and "lightweight" means of work-based learning instead of full degrees (e.g., Suomen Yrittäjät, 2021). Here, the Digital Steps model aligns well. The model is a point-directing example of identifying needs, filling in competence gaps, and visualizing progress in learning to be applied in other types of research development and innovation (RDI) projects.

In the future, we will link the Digital Steps model with open learning badges: standard, verifiable, portable, and shareable digital micro-credentials. Another stream of future activities could be refining Digital Steps activities and outcomes in collaboration with other universities and training organizations, eventually forming larger thematic sets that would be openly accessible at the national level – not merely regionally. This type of program planning has already started for e-commerce development.

In line with Janhunen & Kosonen (2022), we emphasize the importance of establishing easier-to-use measurement tools for demonstrating development in learning new competences and "*changing the mindset of professionals so that customer perspective and real-life data could speak over vague and festive statements of project impact*". For other RDI projects, the key implication is to prepare the project settings and action points to support constant evaluation and analysis of what has been achieved instead of regressive feedback collection.

For educators and development projects, our findings highlight the importance of tailoring the content to match the target audience's needs and focusing on learning-by-doing rather than offering only general information. The lessons from Digital Steps projects underline prioritizing endeavors backed with larger cooperation networks, which have the potential for a more profound impact in improving digital competences and skills.

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3 TOWARDS DATA ECONOMY WITH OPEN SOURCE SOFTWARE

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ABSTRACT

Open-source software (OSS) has the potential to create a basis for a new European digital industry, promoting innovations, changing markets, and increasing digital sovereignty. OSS enables businesses to develop custom solutions, access a wide range of pre-built tools, and collaborate with the community to enhance functionality and performance, providing benefits particularly for small and medium-sized enterprises (SME). At the moment, open source, open data, open standards, and APIs are still not sufficiently systematically promoted. In addition, there is still room for improvement in increasing and supporting collaboration between industry, education and R&D institutions. This article introduces the Resilience and Innovation Capability with Open-Source competence (Open MemoryLAB) project and explains how it will contribute to the strategic objectives on European, national and regional levels. The project seeks to accelerate the adoption of open source software in South Savo with the intention of increasing the vitality of the region. The use of OSS is likely to positively affect existing businesses because they can tailor open-source software to fit their required business process perfectly. The increased use of OSS would, in turn, create new business opportunities, particularly for those who offer OSS-related support services. Furthermore, as OSS also plays a significant role in the data economy, the project accelerates regional companies' transition towards data sharing and developing smart data-driven solutions.

Keywords: Open-source software, FIWARE, data economy, data spaces, competence center

TIIVISTELMÄ

Avoimen lähdekoodin ohjelmistot voivat luoda perustan uudelle eurooppalaiselle digitaaliteollisuudelle, edistää innovaatioita, muuttaa markkinoita ja lisätä digitaalista itsemääräämisoikeutta. Ohjelmistojen avulla yritykset voivat kehittää mukautettuja ratkaisuja, käyttää laajaa valikoimaa valmiiksi rakennettuja työkaluja ja tehdä yhteistyötä yhteisön kanssa toimintojen ja suorituskyvyn parantamiseksi, mikä hyödyttää erityisesti pieniä ja keskisuuria yrityksiä (pk-yrityksiä). Tällä hetkellä avointa lähdekoodia, avointa dataa, avoimia standardeja ja ohjelmointirajapintoja ei vielä riittävän systemaattisesti edistetä. Lisäksi teollisuuden, koulutuksen ja tutkimus- ja kehityslaitosten yhteistyön lisäämisessä ja tukemisessa on vielä parantamisen varaa. Tässä artikkelissa esitellään Resilience and Innovation Capability with Open-Source Competen (Open MemoryLAB) -hanke ja kerrotaan, miten se edistää strategisia tavoitteita eurooppalaisella, kansallisella ja alueellisella tasolla. Hankkeella pyritään vauhdittamaan avoimen lähdekoodin ohjelmistojen käyttöönottoa Etelä-Savossa alueen elinvoimaisuuden lisäämiseksi. Avoimen lähdekoodin ohjelmiston käyttö vaikuttaa todennäköisesti myönteisesti olemassa oleviin yrityksiin, koska ohjelmistoja voi räätälöidä liiketoimintaprosessien mukaan. Ohjelmistojen käytön lisääntyminen puolestaan luo uusia liiketoimintamahdollisuuksia erityisesti niille, jotka tarjoavat niihin liittyviä tukipalveluja. Koska ohjelmistoilla on lisäksi merkittävä rooli myös datataloudessa, hanke vauhdittaa alueellisten yritysten siirtymistä kohti datan jakamista ja älykkäiden datavetoisten ratkaisujen kehittämistä.

Avainsanat: avoimen lähdekoodin ohjelmisto, FIWARE, datatalous, datatilat, osaamiskeskus

1. Introduction

The European Commission has set "*Europe fit for the digital age"* as one of the strategic priorities for 2019-2024. To this end, Europe needs to strengthen its digital sovereignty and establish its own standards, rather than follow those of others, with a clear focus on data, technology, and infrastructure (European Commission, n.d.-a).

The actions towards digital Europe are guided by *the Digital Decade Policy Programme 2030*. This governance framework is based on an annual cooperation mechanism between the Commission and Member States, where Member States propose national strategic roadmaps to attain the objectives set by the Commission (European Commission, n.d.-b) (Figure 1). To attain such objectives on a practical level, the Commission has set up a Digital Compass

to translate the EU's digital ambitions for 2030 into concrete targets and ensure that these objectives will be met (European Commission, 2021a).

Figure 1. Digital Decade policy programme cooperation cycle (European Commission, n.d-c.)

The primary objectives of the European Digital Compass are (European Commission, 2021a):

1. Digital Competitiveness: Increase the global competitiveness of European industries in the digital marketplace.
2. Digital Literacy: Enhance the digital skills and literacy of EU citizens to help them adapt to the rapidly changing digital landscape.
3. Digital Infrastructure: Develop world-class digital infrastructure, including high-speed internet, to support digital services and applications.
4. Data Governance: Ensure secure, ethical, and efficient data governance and data sharing within the EU.

The *Finnish Digital Compass* is the national strategic roadmap describing how the objectives of the Digital Decade 2030 and European Digital Compass are to be attained. It provides the direction for national development work towards digital transformation and the data economy (Valtioneuvosto, 2022). The Finnish Digital Compass acknowledges that the data economy and development of smart digital services depend on how well data can be shared among the stakeholders. The benefits are reaped by combining and analyzing data in new ways. Opening and sharing data to companies of all sizes in an agile way with fair terms would enable the creation of new digital services, processes, and business models. Hence, the Finnish Digital Compass argues that we need to pay increasing attention to

the quality and compatibility of data and to ensure a technologically neutral environment where solutions are compatible in the future, too. (Valtioneuvosto, 2022)

The quest for openness, digital sovereignty, and technological neutrality resonates well with the objectives of Open-Source Software (OSS). OSS has been argued to create the foundation for a new European digital industry, promoting innovations, changing markets, and increasing digital sovereignty (FOSS4SMEs, 2019). Currently, open source, open data, open standards, and APIs are still not promoted systematically enough. In addition, there is still room for improvement in increasing and supporting collaboration between industry, education, and R&D institutions. Thus, there is a clear need to increase the pace of developing innovations towards commercial exploitation. To that end, Open Systems and Solutions should be developed to fit the needs of companies and address the issues raised in the Finnish digital roadmap for 2030.

This article introduces *Resilience and innovation capability with Open Source competence (Open MemoryLAB)* project. It explains how it will contribute to the strategic objectives set by the European and Finnish Digital Compasses. The remainder of this article is organized as follows. We begin by discussing the role of open-source software in attaining the objectives of the EU's digital compass. We then discuss the European strategic objectives to take steps towards sharing data with data spaces and continue to describe FIWARE, the leading open-source technology to support the implementation of data sharing. Next, we introduce the Open MemoryLAB-project and describe our efforts to promote the use of OSS and FIWARE in the Finnish region of South Savo. Finally, we outline our next steps in our chosen path towards the use of OSS and supporting data sharing with FIWARE.

2. Business Benefits and Digital Sovereignty with Open Source Software

> *"Open source software is software with source code that anyone can inspect, modify, and enhance."* (Opensource.com, n.d.)

Often, businesses need to integrate new software seamlessly into their current processes. When using proprietary software, the adjustments will typically have to be performed by the developer of the software vendor, as proprietary licenses usually forbid changes by the licensee or third parties. This kind of *vendor lock-in* causes challenges for businesses in many ways. Due to the lack of competition, a software vendor can set a high price for the adjustments. If the business chooses to change the software to an alternative, it can be impossible to migrate data without the vendor's support. This is also likely to incur high

costs. In contrast, when using OSS, anyone with the necessary skills can tailor the software to fit the required business process. Further, there may already be a solution freely available that others have made. (FOSS4SMEs, 2019).

Due to its open, inclusive, and collaborative nature, OSS can significantly impact the competitiveness of European companies, accelerate economic growth, support the start-up/SME scene, and ensure technological independence (European Commission, n.d.-d; FOSS4SMEs, 2019; Orfanou, 2022).

In essence, OSS enables businesses to develop custom solutions, access a wide range of pre-built tools, and collaborate with the open-source community to enhance functionality and performance. These benefits positively impact several business metrics, including cost savings, freed-up capital, increased productivity, and innovativeness, and yield a higher return on investment (FOSS4SMEs, 2019). Most of these aspects are especially important to small and medium-sized enterprises (SMEs). OSS offers additional benefits to those SMEs developing software themselves. The open and collaborative development process of OSS means that SMEs can take advantage of the work of others, allowing them to focus on differentiated features and, therefore, to increase competitiveness (FOSS4SMEs, 2019). Not only does using OSS positively affect existing businesses, but OSS can create new business opportunities, particularly for those offering OSS-related support services. Since the source code is open, anyone with sufficient competencies can build their business around an existing open-source solution and offer tailoring, training, or technical support services.

3. Towards Data Economy with Data Spaces

> *"Our future digital life will gravitate more and more around data – data describing what is happening around us, when, where, and why."* (Ahle, 2023)

Data is one of the most valuable raw materials of the future (Kippo, 2023) and a key driver of innovation (European Commission, 2021b). The smart use of data can significantly transform all sectors of the economy and create new opportunities for economic growth, including for SMEs (European Commission, 2021b). With the European strategy for data (European Commission, 2023), the EU aims to create a single market for data that will ensure both Europe's competitiveness and data sovereignty. To this end, some important focus areas include the adoption of legislative measures on data governance, access and reuse, the development of technological systems and next-generation infrastructure to enable the EU and all actors to grasp the opportunities of the data economy (European Commission, 2021b).

Existing legacy IT systems are already managing large amounts of data, but data is currently very often organized in silos. In these cases, partners need to share data by connecting to data sources with one-to-one interfaces, which is time-consuming to create and maintain and inflexible when changes occur in the data-sharing network (Ahle, 2023). One key mechanism to mitigate such a challenge is the introduction of common *European data spaces*. These would provide a new way to share data between different organizations and individuals, allowing data from across the EU to be exchanged in a trustworthy manner and at a lower cost, thereby boosting the development of new data-driven products and services (European Commission, 2021b). Consisting of both the secure technological infrastructure and the governance mechanisms (European Commission, 2021b), data spaces replace the one-to-one connections between partners, enabling data-driven collaboration between different partners while remaining very flexible for new partners who were not necessarily known before (Ahle, 2023).

In essence, a data space can be defined as a data ecosystem built around commonly agreed building blocks, enabling the effective and trusted sharing of data among participants to create value (Hierro, 2023). These building blocks include technologies for ensuring (Hierro, 2021, 2023):

- *Data interoperability.* Data spaces should provide a solid framework for efficient data exchange among participants, supporting the full decoupling of data providers and consumers. This requires the adoption of a "common lingua" every participant uses, which materialized in the adoption of common APIs for the data exchange and the definition of common data models. Common mechanisms are also required to trace data exchange transactions and provenance.
- *Data sovereignty and trust*. Data spaces should bring technical means to guarantee that participants in a data space can trust each other and exercise sovereignty over the data they share. This requires adopting common standards for managing participants' identities, verifying their truthfulness, and enforcing agreed-upon policies for data access and usage control.
- *Data value creation.* Data spaces should support the creation of multi-sided markets where participants can generate value from sharing data. This requires the adoption of common mechanisms enabling the definition of terms and conditions (including pricing) linked to data offerings, the publication and discovery of such offerings, and the management of all the necessary steps supporting the lifecycle of contracts that are established when a given participant acquires the rights to access and use data.

As part of the Open MemoryLab-project, one of our objectives is to identify and promote the use of open-source technologies that implement the above-mentioned building blocks for data sharing.

Data interoperability is vital in an open-source ecosystem and the wider data economy. Utilizing common APIs and data models ensures that different platforms, applications, and services can seamlessly communicate with each other. This interoperability allows businesses to be more agile and reduces the time and costs associated with integrating different data streams. From a policy perspective, enforcing such interoperability standards can make the market more competitive and inclusive, allowing smaller players to compete more effectively. Additionally, it aids in regulatory oversight and compliance through standardized traceability of data exchange transactions.

Data sovereignty and trust are increasingly becoming cornerstones of effective data governance. As businesses share more sensitive and valuable data, the ability to exercise control and protection over one's data becomes both a competitive advantage and a governance necessity. Implementing common standards for managing participant identities and access control policies can help build trust within the data ecosystem. Moreover, these standards are essential from a policy viewpoint for ensuring that citizens' data is secure, laying the groundwork for ethical data practices and compliance with data protection laws.

Finally, data value creation is at the heart of the data economy. Common mechanisms for defining terms and conditions can facilitate the process of creating value out of shared data. Regulations that support multi-sided markets can incentivize data sharing and, as a result, drive both innovation and economic growth.

From a data economy standpoint, each aspect—interoperability, sovereignty, and value creation—contributes to creating a vibrant ecosystem where data is not just a byproduct but a valuable asset that can be traded, leveraged, and capitalized upon. Their importance is keenly felt not only at the business level but is highly relevant from a policy perspective, influencing regulations, market competition, and, ultimately, the success of the data economy.

In short, for the local economy, these aspects can be transformative. Data interoperability enables local businesses to integrate seamlessly with larger markets, increasing competitiveness and efficiency. Data sovereignty and trust empower companies and individuals to share and control information securely, attracting more stakeholders to participate in the digital economy. Lastly, data value creation opens new avenues for local entrepreneurship and innovation, driving economic growth. Together, these elements contribute to a more robust, secure, and dynamic local digital economy well-aligned with larger market and policy frameworks.

4. FIWARE – An Open Source Solution Building Block for Enabling the Data Economy

Open-source software plays a significant role in the data economy, enabling businesses to leverage powerful technologies without incurring high costs. FIWARE is an open-source technology used to develop smart solutions, digital twins, and data spaces in several domains of digital transformation (FIWARE Foundation, 2021). It is a curated framework of open-source platform components that enable the development of portable and interoperable smart solutions in a faster, easier, and more affordable way and avoid vendor lock-in scenarios (FIWARE Foundation, 2021).

Providing the necessary technology for the implementation of data spaces, FIWARE has been selected by the European Commission in 2018 as a Connecting Europe Facility (CEF) building block (FIWARE Foundation, 2018b). More recently, the support from the European Commission and the quest for standardization has been realized in the creation of *data spaces business alliance* (DSBA, n.d.), of which FIWARE is one of the founding members and that seeks to converge the best skills assets, and experience in Europe into a one-stop-shop for data spaces, from inception to deployment.

The main and only mandatory component of any "Powered by FIWARE" platform or solution is a *FIWARE Context Broker Generic Enabler* that supplies the essential functionality needed in any smart solution: the need to manage context information, enabling to perform updates and bring access to context (FIWARE Foundation, 2018a). Building around the FIWARE Context Broker, a rich suite of complementary open source FIWARE Generic Enablers are offered, dealing with:

- *Interfacing with the Internet of Things (IoT), robots, and third-party systems* for capturing updates on context information and translating required actuations.
- *Context data/API management, publication, and monetization, supporting usage control and the opportunity to publish and monetize* some of the managed context data.
- *Processing, analyzing, and visualizing context information, implementing the expected smart behavior of applications,* and/or assisting end users in making smart decisions (FIWARE Foundation, 2018a).

FIWARE is not a "take it all or leave it" approach. Developers can combine offered components with other third-platform components to design a hybrid platform for any particular context. As long as the developed solution uses the FIWARE Context Broker technology to manage context information, it can be considered "Powered by FIWARE" (FIWARE Foundation, 2018a).

Due to its openness, desire for standardization, active developer community, and EU support, FIWARE has become widely adopted and a globally leading open-source technology for many domains, including smart cities, industry, energy, and agri-food. In these domains, the FIWARE community has developed reference architectures and data models to accelerate the adoption and further development of FIWARE-based solutions. The community has published a number of impact stories to demonstrate how the technology has been used in real life (FIWARE Foundation, n.d.).

FIWARE's widespread use in various sectors is due to a few key attributes. First, as it is open-source, it is both accessible and modifiable. This allows a wide range of organizations, from small startups to large corporations, to adapt the technology to their specific needs without being concerned about licensing fees or restrictive proprietary systems.

Second, FIWARE aims for standardization. This is important because it makes working together easier for different technologies and systems. In complex environments like a city or an industrial setting, you often have multiple systems that need to communicate with each other. Standardization simplifies this interaction, making things more efficient.

Third, there is a large and active community of FIWARE developers. A community contributes to ongoing improvements, offers user support, and helps to quickly integrate new technologies or methods as they emerge. This keeps the platform relevant and up-to-date.

Fourth, being backed by the European Union gives FIWARE an extra layer of credibility. It shows that the platform is aligned with broader policy objectives, such as promoting digital innovation and sustainability, which can be especially important for public sector adoption.

Therefore, FIWARE's wide adoption comes from its flexibility, its commitment to making systems work well together, its active community, and the institutional support it receives. These factors together make it a reliable and adaptable choice for organizations in a variety of sectors.

5. The Open MemoryLab Project

The *Resilience and Innovation Capability with Open-Source Competence (Open MemoryLAB)* project (XAMK, n.d.) seeks to strengthen companies' change and innovation capabilities by offering them consultancy, guidance, and training for utilizing open-source software in their business and digitalization development efforts. During the project, industry needs

are researched, and open-source solutions are proposed for the identified needs of companies. The proposed open-source solutions are then collaboratively evaluated to understand better their competence needs and interest in utilizing OSS. The project results in a plan for establishing an open-source competence centre and building collaborative ties with industry and international and national partners. The project was implemented between October 1st, 2022, and December 31st, 2023, in collaboration with the South-Eastern Finland University of Applied Sciences (Xamk) and the Finnish Centre for Open Systems and Solutions (COSS). The project has received funding from the European Social Fund (REACT-EU), awarded by the South Savo Centre for Economic Development, Transport and the Environment.

6. Towards Open Source Competence and a Data Economy in South Savo

A large proportion of businesses in South Savo are SMEs, and, like many other European SMEs (FOSS4SMEs, 2019), they seem to lack the necessary skills and resources to adapt their business to digital transformation. In this article, we discussed the use of OSS and explained several of its benefits for SMEs. Thus, the objective of establishing an OSS competence centre for the South Savo region in Finland is a worthwhile endeavor.

The need for promoting OSS through competence centers has been recognized at the European level. In a recent report by the European Commission (Directorate-General for Communications Networks et al., 2021), the impact of open-source software and hardware on technological independence, competitiveness, and innovation in the EU economy was explored with policy recommendations, including:

- creating a Commission-funded network of Open-Source Project Offices intended to support and accelerate open technologies' consumption, creation, and application.
- promoting digital autonomy and technological sovereignty via Open Source.
- Higher Education Institutions in the Member States provide entrepreneurial skills facilitating OSSH based start-ups, e.g., in Master programs on entrepreneurship, and ICT studies.

In a similar vein, a policy recommendation report focusing on the use of OSS for SMEs (FOSS4SMEs, 2019) has recommended, among other things, to:

- increase the diversity of technology education, making digital jobs, such as at OSS SMEs, more attractive.
- realize the value of transferable and sovereign digital competences by moving away from teaching specific product knowledge toward generic competences instead.

Open MemoryLab project's objective for establishing an OSS competence center in South Savo is aligned with European, national, and regional strategies. While serving regional businesses, most of which are SMEs, the competence center can help to increase the viability of local businesses while increasing digital sovereignty and OSS awareness on a larger scale. Many of the proposed policy recommendations are related to improved services towards SMEs or developing education programs to include OSS-related viewpoints. This creates a good opportunity for South-Eastern Finland University of Applied Sciences – Xamk to support the adoption of OSS and digital transformation towards the data economy.

As a first step, we joined the international FIWARE community and have been awarded an incubated FIWARE iHub status (FIWARE Foundation, 2020) for supporting companies, cities, and developers in their innovation and digitalization journey by offering easy access to Open-Source technologies, business development support, and community building. As the next step, we focus on establishing an OSS competence center for the South Savo region. To this end, we plan to establish services for regional companies to support the adoption of OSS and advise the companies on OSS business opportunities. We plan to strengthen the role of OSS in Xamk's research, development, and innovation (RDI) projects and find opportunities to include OSS-related topics in teaching. As part of this work, we will strengthen the recently founded regional FIWARE iHub and help companies with their digital transformation towards the data economy with the help of the international community. With these actions, we intend to support the creation of data spaces in many business domains, and thus accelerate the data economy transition in South Savo. In practice, this would mean better opportunities for companies to take advantage of data for developing smart data-driven services.

In the future, the commitment to open-source competence and the development of a data economy in South Savo could radically change the landscape for local companies, particularly SMEs. These small and medium-sized enterprises are thriving, in part due to their enhanced capability to adapt to digital technologies without the prohibitive costs of proprietary systems. Open-source software will provide these companies with the ability to innovate quickly and respond to market changes in real time. This agility will become a key competitive advantage.

As educational programs adapt to include more open-source software and data management, we can expect a new generation of tech-savvy entrepreneurs and employees to emerge. These individuals will be the driving force behind more digitally competent and globally competitive local companies. The implications could be significant, ranging from job creation to attracting investment and talent to the region.

Being part of global networks like FIWARE will open doors for local companies. The international exposure will lead to collaborations and partnerships that could perhaps extend the companies beyond Finland's borders. Through knowledge exchange and collaboration, local SMEs could grow exponentially, tapping into markets and opportunities that were previously out of reach.

The alignment of these local initiatives with broader European and national strategies cannot be understated. This could potentially open avenues for additional funding and policy support, amplifying the benefits for local companies. Moreover, by proactively adopting technologies and practices endorsed at a national or even continental level, businesses in South Savo will be ahead of the curve, positioning themselves favorably for new opportunities or challenges the future may bring.

In a data-driven future, effectively gathering, analyzing, and acting upon data will be critical. Open-source platforms will offer tools that even SMEs can use to make data-driven decisions, leveling the playing field with much larger competitors.

So, looking forward, the South Savo region has a unique opportunity to not only catch up with but even surpass other regions in terms of technological adaptability and business competitiveness. By laying the foundation now through an open-source competence center and focusing on the data economy, South Savo can position itself as a future hub for digital innovation and economic resilience.

7. Conclusions

In this article, we have discussed how open-source software has a key role in attaining the European strategic objective of making "Europe fit for the digital age". As the EU aims to create a single market for data that will ensure both Europe's competitiveness and data sovereignty, we need interoperability that allows businesses to be more agile and reduces both the time and costs associated with integrating different data streams. To this end, an open-source ecosystem, such as FIWARE, is vital in offering common APIs and data models, ensuring that different platforms, applications, and services can seamlessly communicate with each other.

By establishing the *Resilience and innovation capability with the Open Source competence (Open MemoryLAB)* project, we are making an effort to promote the use of open-source technologies and help regional companies take steps towards the data economy.

As regions and countries seek to advance their economies in an increasingly digital world, the convergence of Open Source Software (OSS) with the burgeoning data economy offers a compelling path forward. In particular, regions like South Savo in Finland stand at a critical juncture where this intersection of open-source technology and data-driven approaches could be a watershed moment for local economic development. For small and medium-sized enterprises (SMEs), which often lack the resources for large-scale digital transformation, OSS provides an accessible and cost-effective way to modernize, innovate, and compete in global markets.

The initiatives to develop OSS competence centers in South Savo are not merely localized efforts but align with broader policy frameworks at both the national and European Union levels. This alignment could act as a multiplier by unlocking additional funding streams, fostering cross-border collaborations, and integrating local businesses into expansive markets. Moreover, European backing adds credibility and urgency to these local efforts, making them part of a continent-wide drive to bolster digital competencies, autonomy, and sovereignty.

As education systems integrate OSS and data economy principles into their curricula, we can anticipate the emergence of a new, tech-savvy workforce. These individuals will be equipped with technical skills and an understanding of how to leverage these skills for entrepreneurial endeavors. This workforce will become a cornerstone for local companies, fuelling growth from within and attracting external talent and investment to South Savo.

Furthermore, active participation in international OSS communities like FIWARE presents an invaluable opportunity for local companies to collaborate with global players. These interactions are gateways to new markets, technologies, and business models, providing local businesses the tools and exposure to scale their operations beyond regional boundaries.

As the world becomes more data-centric, the ability to harness this data for actionable insights will be a key differentiator for businesses of all sizes. OSS platforms and tools offer scalable solutions for collecting, analyzing, and interpreting data, enabling even smaller companies to make informed, strategic decisions based on real-time information.

To conclude, as South Savo and similar regions invest in the symbiotic relationship between OSS and the data economy, they lay the groundwork for a dynamic and resilient economic landscape. This investment promises short-term gains and long-term transformations, setting the stage for a future where local businesses participate in the global data economy and influential players shape its course. The road towards a data economy powered by Open Source Software is not just a technological shift but an economic and social revolution that promises renewed growth, innovation, and global competitiveness.

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4 CHALLENGES IN MAPPING INTER-ORGANIZATIONAL RELATIONS IN A REGIONAL CIRCULAR ECONOMY

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ABSTRACT

The need for a transition towards sustainable, intelligent sociotechnical systems and a circular economy has been widely recognized. Digitalization enables the circular economy by improving knowledge, connections, and information sharing, which helps in raising awareness and guiding action toward a sustainable circular economy. By delivering a case example of regional circular economy research, development, and innovation (RDI) network data collection, this article provides an analysis of the usability and usefulness of information systems in circular economy network mapping. By collecting data from customer data systems and project management systems of South-Eastern Finland University of Applied Sciences (Xamk), we identify opportunities and problems in utilizing and developing the use of these systems in project and network management. The research showcases how information systems that do not currently intentionally support circular economy reporting can be utilized for circular economy RDI network data collection and what obstacles are involved in doing so.

The work provides bases for further research and development of digitally enabled solutions to facilitate connections and partnerships between stakeholders in circular economy RDI networks. Ultimately, creating efficient ways of conducting regional circular economy network mapping would help in allocating development measures more productively and in monitoring the effectivity of such measures. In time, better network data management would facilitate collaboration and actions toward a sustainable circular economy based on regional characteristics and development opportunities.

Keywords: circular economy, network mapping, data management, RDI, digitalization

TIIVISTELMÄ

Tarve siirtyä kestäviin, älykkäisiin sosioteknisiin järjestelmiin ja kiertotalouteen on tunnustettu laajalti. Digitalisaatio edistää kiertotaloutta parantamalla osaamista, yhteyksiä ja tiedon jakamista, mikä ohjaa toimintaa kohti kestävää kiertotaloutta. Tämä artikkeli tarjoaa case-esimerkin alueellisesta kiertotalouden tutkimus-, kehittämis- ja innovaatioverkostojen tiedonkeruusta analysoimalla tietojärjestelmien käytettävyyttä ja hyödyllisyyttä kiertotalouden verkostokartoituksessa. Keräämällä tietoa Kaakkois-Suomen ammattikorkeakoulun (Xamk) asiakastietojärjestelmistä ja projektinhallintajärjestelmistä tunnistamme mahdollisuuksia, ongelmia ja kehittämiskohteita näiden järjestelmien käytön hyödyntämisessä projektin- ja verkostonhallinnassa. Tutkimus osoittaa, miten tietojärjestelmiä, joita ei nykyisellään ole suunniteltu tukemaan kiertotalousraportointia, voidaan hyödyntää kiertotalouden TKI-verkoston tiedonkeruussa ja mitä esteitä siihen liittyy. Tehty tutkimus luo pohjaa digitaalisten ratkaisujen jatkotutkimukselle ja kehittämiselle kiertotalouden TKI-verkostojen sidosryhmien välisten yhteyksien ja kumppanuuksien helpottamiseksi. Viime kädessä tehokkaiden työkalujen ja käytänteiden luominen alueellisen kiertotalouden verkostokartoituksen tekemiseen auttaa kohdentamaan kehittämistoimenpiteitä tuottavammin ja seuraamaan toimenpiteiden vaikuttavuutta. Näin datan parempi hallinta helpottaa yhteistyötä ja edistää toimia kohti alueellisiin erityispiirteisiin ja kehitysmahdollisuuksiin pohjautuvaa kestävää kiertotaloutta.

Asiasanat: kiertotalous, verkostokartoitus, datanhallinta, TKI, digitalisaatio

1. Introduction

In current times of urgent environmental crises, transitioning towards sustainable, intelligent sociotechnical systems is essential (Okorie, et al., 2018). The ongoing rapid changes in the Earth system have already had significant global societal impacts undermining critical life-support systems, including global warming, biodiversity loss, and disturbance of the nutrient cycle. These changes are driven mainly by social and economic systems based on unsustainable resource extraction and consumption (Rockström, et al., 2023). These factors indicate an urgent need to progress from a linear to a circular economy (Neligan, 2018).

In a circular economy, the material loop is closed. Materials are kept in the economic circle by reducing, reusing, refurbishing, repairing, and recycling (Ellen MacArthur Foundation, 2017). The circular economy is an economic system that replaces the 'end-of-life' concept by keeping materials in production/distribution and consumption processes (Kirchherr, Reike, & Hekkert, 2017). The concept can be applied to the micro level (products, companies, consumers), meso level (eco-industrial parks, etc.), and macro level (city, region, nation, and beyond) to accomplish sustainable development (Kirchherr, Reike & Hekkert, 2017).

However, the transition from a linear to a circular economy has been slow. Despite the nationally ambitious goals and circularity strategies (Finnish Ministry of the Environment, 2021), Finland is performing poorly in the ranking of circularity development in European countries. For example, the national circular material use rate has decreased significantly during the previous decade (European Environmental Agency, 2023). Even though there has been much research on different circular applications and technologies, its implementation and scale-up in industry and society have failed. Still, the circular economy is expected to have net positive benefits in terms of GDP growth and job creation in the future (European Parliament, 2023).

Structural networks are especially valuable when the operating environment changes (Järvensivu, 2019, s. 46). This is particularly relevant regarding the transition to a circular economy and digitalization. It has also been recognized that it is important for higher education institutions to identify and classify stakeholders explicitly (Kettunen, 2014). However, it should be noted that the educational and RDI functions and their networks differ in their objectives and means of collaboration. Network research is primarily based on resource dependence theories that suggest that we are all dependent on the resources of others (Järvensivu, 2019, p. 20; Hillman, Withers, & Collins, 2009), which is even more emphasized in circular economy networks. The interlinkages exist within higher education institutions between research units, projects, education, and RDI, as well as within different regional, national, and international networks.

Digitalization has been identified as an enabler of the circular economy (Antikainen, Uusitalo & Kivikytö-Reponen, 2018), improving knowledge, connections, and information sharing (European Commission, 2020). A digital green transition is needed to achieve a comprehensive societal transformation in which all sectors adopt relevant technologies contributing to a low-carbon society. A systemic change towards a circular digital economy is pursued by integrating digital and green policies and research, thus supporting the development of digital technologies and solutions positioned to achieve climate mitigation and sustainability (Nordic Council of Ministers, 2021, p. 6). Better data management to improve information and knowledge can raise awareness and guide action towards a sustainable circular economy (European Commission, 2020, p. 18). At the same time, it is important to assess safe and just boundaries for the Earth's system resilience and human well-being within an integrated framework to be able to consider the interdependencies between inclusive human development and a stable and resilient Earth system (Rockström, et al., 2023).

The circular economy has an amplified regional nature compared to a linear economy. Closed material loops are achieved through, e.g., industrial symbiosis and local reusing, refurbishing, repairing, and recycling services and sharing economy solutions. Material availability and logistics often have a significant role in making or breaking a circular business. Henrysson and Nuur (2021) have identified the following institutional determinants of transformation toward a circular economy in a regional context: (i) proximity of physical flows and assets, (ii) maturation and diversity of market networks, and (iii) inherent values and patterns of cooperation. According to Silvestri, Spigarelli, and Tassinari (2020), "the support of regional policies is essential to implement CE principles, considering the relevance to, and importance of, wider territories than urban areas, and also the need for a more focused approach than on CE at the national level."

Through a case study, we analyze the usability and usefulness of information systems in mapping regional circular economy research, development, and innovation (RDI) networks. The case study focuses on the Kymenlaakso region, utilizing material from customer data systems and project management systems at the South-Eastern Finland University of Applied Sciences. We collect data from available information systems to map out inter-organizational relations within circular economy RDI and identify opportunities and problems in utilizing and developing these systems in circular economy network management.

Kymenlaakso was chosen as a focus region because the regional smart specialization strategy's priorities include regional circular economy and data economy (The Regional Council of Kymenlaakso, 2021). In Kymenlaakso, the regional circular bioeconomy RDI ecosystem emphasizes regional development and applied research, closely related to the regional busi-

ness ecosystem and industry. The relations between the other regional smart specialization priorities of green logistics and the data ecosystem also have great potential. Mapping the circular economy RDI network helps show the current state of the network as it makes it possible to determine gaps in RDI collaboration and asses its quality and development potential.

2. Data and Method

The utilized data was collected from the innovation project portfolio management system and the Customer Relationship Management (CRM) software of South-Eastern University of Applied Sciences - Xamk, the largest RDI organization in the region. The data was reviewed and analyzed as part of the 'DIKIEKO – Digital Circular Economy Ecosystem' project funded by the regional council of Kymenlaakso as part of the European Union's response to the COVID-19 pandemic. The data collection was executed in spring 2023 to test digital tools and software that can be utilized and developed to foster circular economy development and RDI.

The data collection started with the identification of ongoing and finished regional or regionally implemented national and international circular economy RDI projects from the innovation project portfolio management system. Based on the network organization data and circular economy RDI-project listing, data collection was continued from CRM software, which was presumed to include more specific data related to the collaboration between stakeholders. The data collection included several search rounds with different search terms. Different ways were experimented with to overcome various difficulties in gathering the needed data. We identified gaps in the network data based on the data collection from the innovation project portfolio management system and the project teams' knowledge of regional circular economy RDI projects.

The data collection and analysis process in Microsoft Dynamics CRM involved a systematic approach to gathering and analyzing information related to accounts and their relationships with projects. This process is essential to gain insights into customer interactions in different projects. The primary data sources in this process were accounts and projects, which were stored within the Microsoft Dynamics CRM system. Accounts represented Xamk's customers or participants in projects, while projects encompassed various initiatives or engagements in RDI projects.

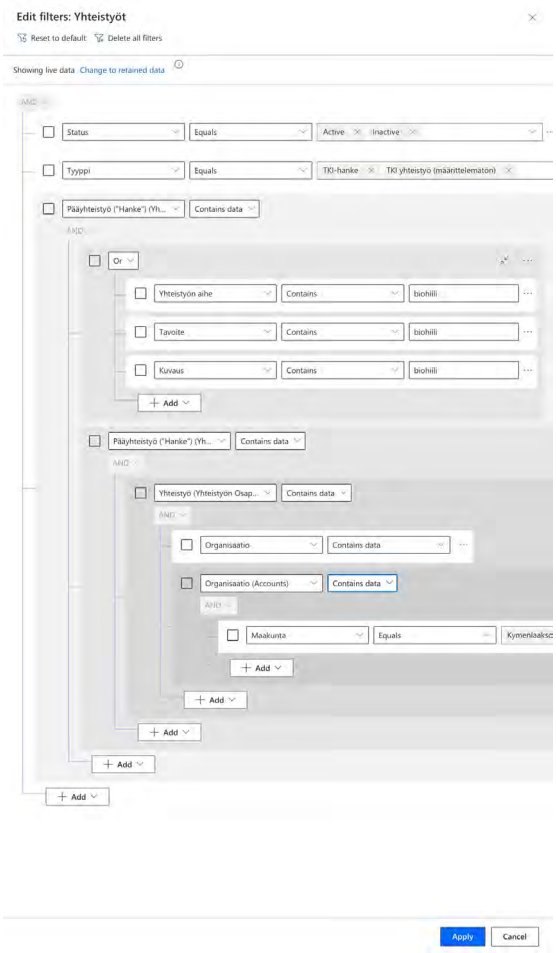

Fig. 1. Using a filtering tool for finding relevant content from projects by using keywords and getting results only for those projects with included organizational data. An additional requirement is needed to include companies from selected regions. (Jani Kiviranta, 2023)

Networks can be mapped in different ways for different purposes. In this paper, we decided to map stakeholders using Mendelow's Stakeholder Matrix (Mendelow, 1981). Still, we wanted it to be a digital version based on our CRM information and additional data from the Hansa project portfolio management system. Mendelow's Matrix is a tool used to analyze stakeholders based on their level of interest and power in relation to a project or initiative. This matrix helps categorize stakeholders into four groups: High Power-Low Interest, High Power-High Interest, Low Power-Low Interest, and Low Power-High Interest. The mapping is done manually using visualization tools.

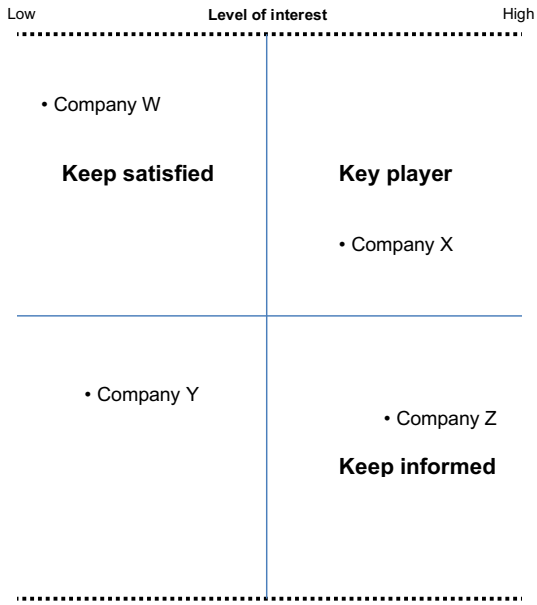

Fig. 2. Mendelow's power and interest matrix (Mendelow, 1991)

Applying Mendelow's Matrix (Mendelow, 1981) to CRM provides a structured approach to managing stakeholder relationships and tailoring engagement strategies. In practice, the project manager can focus more efficiently on stakeholders' needs and impact on project success. In the circular economy RDI context, this helps in achieving a greater regional development impact and fast-tracking regional circular economy development by planning projects so that they are firmly connected to specific development needs of regional companies and business clusters as well as being able to target RDI actions and communication of results as efficiently within the regional circular economy RDI network.

Power is one of the main stakeholder characteristics used to classify stakeholders as it indicates the ability to affect the implementation and/or outcomes of a project (Nguyen & Mohamed, 2018). Mendelow's Matrix is widely used and has been applied in sustainability contexts and, for example, to assess the social acceptance of sustainable technology (Markwick, 2000; Ludovico, Federica, & Bonaiuto, 2020). Mendelow (1991) suggests we analyze our stakeholder groups based on these two areas:

1. **Power:** The ability to influence an organization's strategy or project resources
2. **Interest:** How interested they are in the organization or project succeeding

High Power-High Interest (Key players): These stakeholders have both high power and high interest in circular economy RDI projects (Mendelow, 1981). In the context of CRM, these might be the most important customers, strategic partners, or regulatory bodies. For this

group, the project would want to establish strong relationships, provide regular updates, seek their input, and involve them closely in projects. CRM can help track their preferences, interactions, and expectations, allowing for customizing communication and engagement strategies.

High Power-Low Interest (Keep satisfied): These stakeholders have significant power but lower interest in projects (Mendelow, 1981). They might include top-level executives or governmental bodies. While they might not be directly involved, they can impact the initiatives of projects. CRM can be used to periodically update them on the progress of a project, ensuring they are satisfied. CRM can also help automate reminders for communication.

Low Power-High Interest (Keep informed): These stakeholders have high interest but relatively low power (Mendelow, 1981). This group might include local communities, non-governmental organizations (NGOs), or certain customers. With CRM, projects can create targeted communication channels to keep them informed. Regular updates and information sharing can help maintain their interest and support.

Low Power-Low Interest (Monitor): Stakeholders with low power and low interest (Mendelow, 1981) might include the general public or individuals who are minimally affected by the work of projects. While not requiring extensive engagement, being aware of their sentiments is good. CRM can help automate sentiment analysis, social media monitoring, or surveys to gauge their perceptions and address any negative sentiment early on.

We recognize that the dataset should be further complemented with the network data of, for example, regional development organizations operating in the region and other research and education organizations to expand the view of the circular economy RDI ecosystem. However, the analysis gives a preliminary network view based on the current data. More importantly, it identifies opportunities and barriers to utilizing innovation project portfolio management and CRM software in RDI-network mapping.

3. Mapping of inter-organizational relations in circular economy RDI

Even identifying stakeholders in the circular economy, RDI was proven problematic, as the description of collaboration rarely includes the word “circular economy” as such. However, project proposals and descriptions often refer to a circular economy. Thus, we started by identifying circular economy-related projects and collaboration related to them. Based on multiple data collection rounds from the CRM software, a map of RDI collaboration was drafted. Bilateral collaboration was identified between stakeholders to sort the findings by the extent and depth of collaboration.

Circular economy RDI collaboration can be described as joint development, participatory, learning/information oriented, or consultancy oriented. In joint development projects, different organizations are involved in the planning and execution of a project. They all learn and benefit from participating in a project and have their own interests and roles accordingly. The circular economy RDI collaboration identified includes international, national, and regional circular economy projects. The collaboration and consortiums usually have continuity, and the same partners are often involved in multiple projects.

Organizations can also be involved in circular economy RDI by participating in different inclusive actions, like workshops, experiments and trials, design sprints, and case studies, among others, and by providing case studies for students. This type of collaboration focuses on the actual needs of stakeholders and supports the creation of trust in networks.

Many circular economy RDI projects focus on learning or increasing knowledge. In these cases, the knowledge needs are collected from stakeholder groups through surveys and interviews, and the results and outcomes of projects are communicated to the target groups through publications, reports, social media posts, events, presentations, training, and so on. These forms of communication are often one-way-oriented and may lack continuity.

In this paper, we examined different approaches to how CRM software could be utilized and customized in RDI projects. Focusing on Xamk, we focused on RDI projects connected with circular economy development. Seven key elements arose from the data:

- Stakeholder engagement and collaboration
- Data collection and analysis
- Mapping interorganisational relations
- Project management and monitoring
- Obstacle identification and problem solving
- Partnership facilitation
- Knowledge sharing

These seven points are important because they provide a structured and strategic approach to managing stakeholder relationships within CRM, enabling organizations to engage with stakeholders efficiently, tailor communication strategies, allocate resources effectively, and gauge the impact of their initiatives, all of which are crucial for successful circular economy RDI projects.

In the following sections, we will delve into these seven key elements to comprehensively understand how CRM software can be a pivotal tool in enhancing circular economy RDI projects. This exploration aims to offer practical insights and actionable strategies for organ-

izations looking to leverage CRM in the realm of circular economy research, development, and innovation.

Stakeholder engagement and collaboration: CRM systems can help manage relationships with various stakeholders involved in circular economy RDI networks, including businesses, researchers, government agencies, and NGOs. These systems can facilitate communication, collaboration, and knowledge sharing among diverse participants. A CRM platform centralizes contact information, communication history, and project details, making it easier for stakeholders to stay connected and engaged. As the development of the circular economy depends on connecting knowledge areas that may seem separate from each other in a linear economic model, engagement and collaboration fostering the ability of network management is essential.

Data collection and analysis: CRM systems can be customized to collect relevant data about circular economy projects, such as resource usage, waste management strategies, and supply chain information. By analyzing this data, organizations can identify trends, best practices, and areas for improvement in their circular economy initiatives. They are combined with network data and collaborative measures for reducing, reusing, refurbishing, repairing, and recycling practices to keep materials in the economic circle.

Mapping inter-organizational relations: CRM systems can aid in visualizing these relationships by tracking interactions, partnerships, and collaborations between entities. This mapping can provide insights into a network's dynamics, helping identify key players and potential areas for expansion. This is important in the project's planning phase and implementing circular economy RDI results effectively. The development of circular economy networks is built upon existing collaboration. However, it also depends on finding ways to overcome knowledge gaps and building new cross-sectoral network structures. To manage this, organizations need information about circular economy-related actions and an overview, making it possible to identify knowledge gaps, etc.

Project management and monitoring: CRM systems can serve as project management tools, helping teams track project milestones, tasks, and timelines. Especially beneficial is to develop the integration between project portfolio management and CRM systems, which allows coordination of networking actions across teams and projects.

Effective networking between stakeholders, project owners, and companies is critical to advancing circular economy initiatives. CRM systems provide a centralized platform for stakeholders to share information, foster collaboration, and establish new connections. By leveraging CRM functionalities, project owners can streamline communication channels,

facilitating the exchange of knowledge and resources between diverse entities involved in circular economy RDI projects. This networking capability enables organizations to bridge knowledge gaps, forge cross-sectoral partnerships, and create a robust foundation for collective action. The ability to connect stakeholders seamlessly within a CRM framework promotes synergy, allowing circular economy networks to capitalize on shared expertise and drive impactful, sustainable outcomes.

These systems can also integrate sustainability metrics for circular economy projects, allowing teams to monitor progress toward circular economy goals and make data-driven decisions.

Building upon the networking capabilities discussed earlier, CRM systems can play a pivotal role in achieving obstacle identification and problem-solving within circular economy initiatives. CRM data becomes a valuable resource for pinpointing obstacles and possibilities between collaborators and stakeholders. These systems can also integrate sustainability metrics for circular economy projects, allowing teams to monitor progress toward circular economy goals and make data-driven decisions.

Obstacle identification and problem-solving: There are challenges in utilizing existing systems for circular economy reporting. CRM systems can help identify these obstacles by tracking user feedback, system usage patterns, and areas where functionality falls short. This data can guide improvements and customization efforts to align the systems more effectively with circular economy requirements.

Partnership facilitation: Digitally enabled solutions can facilitate connections and partnerships within circular economy RDI networks. CRM systems can play a role in matchmaking, suggesting potential collaborators based on their profiles, interests, and expertise. By leveraging digital solutions, CRM acts as a matchmaker, intelligently suggesting potential collaborators based on their profiles, interests, and expertise. This enhances the efficiency of partnership formation, fostering synergies that drive innovation, knowledge exchange, and collaborative problem-solving, ultimately advancing the collective goals of circular economy research and development initiatives.

Knowledge sharing: CRM systems can include knowledge bases and training modules related to circular economy concepts and practices. This utilization of CRM technology marks a paradigm shift in the contextual application of digital solutions, particularly in the realm of circular economy RDI projects. By integrating knowledge-sharing functionalities, CRM systems can transform into dynamic platforms facilitating project management and serving as repositories of expertise and resources. The convergence of project management,

networking, and knowledge sharing based on CRM data enhances efficiency and effectiveness, representing a forward-thinking strategy that aligns technology with the holistic needs of circular economy initiatives.

This helps stakeholders stay informed about the principles of circular economy and encourages adopting sustainable practices. Encouraging adopting sustainable practices through knowledge sharing adds substantial value to the future of circular economy projects. As stakeholders are equipped with comprehensive insights, they become empowered advocates for sustainable methodologies. This contributes to the immediate success of RDI projects and lays the groundwork for a broader cultural shift toward circular economy principles. The long-term value lies in the ripple effect created by informed and engaged stakeholders who, armed with the knowledge imparted through managed knowledge systems like CRM, actively champion sustainable practices in their respective spheres. This adoption of sustainable practices aligns with environmental and societal goals and enhances the overall resilience and viability of circular economy initiatives in the face of evolving challenges.

Collaboration within the regional circular economy network, including research organizations and companies, can be constant, occasional, periodic, or isolated, and it may or may not be limited to circular economy RDI collaboration. By using CRM tools to manage several successive projects, the continuous use of data is enabled, thus, in turn, fostering sustainability in RDI project implementation to manage the shift from a linear approach to a circular one. As the structure of the regional circular economy innovation network is evolving, the analysis should include key stakeholder perspectives as well as network analysis. Data collection, methods, and analysis should be developed with digital tools to make this possible.

4. Identified development opportunities and research needs

The research demonstrates the systemic nature of digital green transition and circular economy and provides the means to utilize data systems to analyze regional circular economy RDI-ecosystem development. While the identified development needs are primarily applicable for network mapping in other areas, some barriers relating to terminology and definitions were identified due to the multidisciplinary nature of the circular economy.

Circular economy innovation networks are often complex and cross traditional industry and research discipline boundaries. Thus, analyzing network data from existing data sources may be difficult, even though necessary, to support circular economy project management and

innovation ecosystem development. Circular economy-related collaboration is often explicated by using other words, i.e., recycling, repair, sustainability, material efficiency, low carbon, energy efficiency, renewability, climate neutrality, or upscaling. It requires some understanding of the concept and knowledge of collaboration to identify whether certain collaboration measures are connected to the circular economy. It is also a relevant question whether circular economy RDI is the best categorization or would be more beneficial to, for example, mapping sustainability-related RDI collaboration(s). This could encompass a wider scope of measures or, on the contrary, go deeper into different RDI themes within the circular economy.

The effective usage of CRM is based on qualified data. Our analysis noted that gathering data from the private sector for circular economy research and development initiatives can be challenging for several reasons.

Data privacy and confidentiality is often a concern for businesses. Private sector organizations are often protective of their sensitive business data. This can include proprietary information, customer data, and competitive strategies. Sharing such information for research purposes might raise concerns about data privacy and confidentiality, especially if there is a fear of information being misused or leaked. Private companies may not be directly incentivized to share their data with research projects unless they see clear benefits for their business. They might be hesitant to provide data if they do not perceive a tangible advantage in terms of improved operations, cost savings, or reputation.

The quality and consistency of data collected from various private sector entities can be challenging. Different organizations might use varying data formats, units of measurement, and categorizations, making it difficult to harmonize and analyze the data effectively. Private sector data can be complex and scattered across various systems and departments. Access to this data might require navigating through multiple layers of bureaucracy, negotiation, and technical integration challenges. Also, the lack of standardized data reporting frameworks and definitions in the private sector can make comparing and analyzing data from different sources difficult. This can hinder the overall accuracy and reliability of the research findings.

There are often competing priorities in business. For example, private sector organizations have their own operational goals and projects to focus on. Participating in data collection for research might not align with their immediate priorities, leading to a lower willingness to dedicate time and resources to data sharing. Limited resources: Smaller businesses, especially in regions like Kymenlaakso, where local businesses are small companies, might lack the necessary resources (financial, technical, and expertise) to participate in data collection efforts. They might be unable to extract and provide the data in a usable format, hindering their involvement.

Trust and risk management are crucial for the open sharing of data (Järvensivu, 2019). Building trust and establishing a positive reputation might take time and resources. Some businesses might be cautious about sharing data with external parties due to concerns about how it will be used or whether research findings could negatively affect their reputation. Comprehensive risk management builds trust among private companies. They might perceive risks associated with data sharing, such as exposing vulnerabilities or weaknesses in their operations, which competitors or regulatory authorities could exploit. Further to trust, there may also be underlying organizational cultures that impact the attitude toward collaboration and data sharing. Some industries may have a more open culture, while others may be more closed-off and guarded.

Data sharing beyond the boundaries of a private organization might be limited due to regulation. Depending on the industry and location, private sector organizations might be subject to strict regulations governing data sharing and protection. Compliance with these regulations can create additional hurdles for sharing data.

To address these obstacles, researchers and policymakers must establish clear communication channels, build trust, demonstrate the benefits of data sharing, and ensure that data collection processes respect privacy and regulatory requirements. Collaboration between public and private sectors, offering incentives for participation, and showcasing successful case studies of data-driven improvements in circular economy initiatives can also encourage private sector engagement.

Digitally enabled solutions should be developed to facilitate connections and partnerships between stakeholders in circular economy RDI networks. We argue that this would help direct resources in a way that most effectively supports the implementation of regional, national, and international circular economy strategies. Circular economy RDI networks are often based on regional capabilities, making them more vulnerable to having operational or knowledge gaps in the network structures. Thus, network mapping provides key information in making circular economy RDI more effective.

We found that circular economy RDI collaboration may be linked to a project, network, partnership, or a specific theme or substance within the larger scope of the circular economy. It would be beneficial to be able to view the RDI network through these different lenses. The analysis of micro, meso, and macro levels of circular economy development would be interesting in the strategic sense, especially in evaluating the scope and impact of circular economy-related regional development and RDI efforts. By developing network mapping and analysis, the risks connected to communication, such as a lack or an abundance of communication or missing the target, could be mitigated. Further, a better fit between project measures and target group needs could be achieved, increasing the impact of regional circular economy RDI.

5. Conclusion

To reach the circular economy development goals of regional, national, and EU strategies, a better knowledge of circular economy RDI and business networks is needed. Digitalization is an essential enabler for the circular economy, improving knowledge, connections, and information sharing, all dependent on network management and development. These mechanisms can support the development of digital network management tools and data analysis.

Integrating and automating the principles of Mendelow's Matrix (Mendelow, 1981) into the circular economy network management would enhance the ability to segment stakeholders by classifying them into appropriate categories based on their power and interest levels, ensuring a more targeted and efficient engagement approach. Personalizing communication by utilizing CRM data to tailor communication and engagement strategies to each stakeholder group's preferences and needs and prioritizing resources by allocating resources and efforts more effectively by focusing on high-power stakeholders with significant interest while maintaining appropriate engagement with other groups. Automating engagement using CRM automation features to schedule regular updates, reminders, and communication based on each stakeholder group's requirements. Tracking engagement history by maintaining a record of interactions and engagement history with each stakeholder group, aiding the identification of trends and assessment of the effectiveness of engagement strategies over time.

Ultimately, integrating Mendelow's Matrix (Mendelow, 1981) into a CRM system could tackle many hurdles in its utilization in circular economy networks and project management. It enhances the ability to manage stakeholder relationships strategically, align communication efforts, and ensure that circular economy RDI initiatives receive support and collaboration from various stakeholder groups. Further, from a data collection perspective, the quality of the matrix is based on reliable first-hand data. In this way, many of the usual problems of gathering, evaluating, and processing data can be finetuned quickly.

Data gathering should be improved to facilitate the transition to a circular economy. Our case study found that the CRM system had established very limited relationships between accounts and projects, associating each project with the corresponding account. The reason for this may vary. Some see the CRM system as an additional task and share the bare minimum of data, usually company contact data. More elaborate descriptions of the collaboration with companies and other stakeholders in different projects should be inputted into the system to produce valuable findings. We argue that the possibility of developing the user experience of RDI network data management systems towards a project-centric user path should be pursued in the future. The following figure describes the process for

finding possible companies for the project. The user should type keywords that would reveal relevant projects and means of collaboration.

The circular economy is desired over linear business models, so relevant innovation networks cannot be scattered, biased, or dysfunctional. However, without comprehensive network data, the state of the network development is impossible to evaluate or develop. Regional analysis can pinpoint problems, and development needs applicable to other regions at the national and global levels. The scale of problems related to data gathering and management is only amplified when compared to organization-level analysis. Network knowledge is vital in seeing the big picture and preventing such measures that may seem to add circularity and sustainability in one part of the system or life cycle but, in reality, only transfer it or, in the worst-case scenario, add to the environmental impacts in other parts of the system. To support the development and business within the safe and just boundaries for Earth system resilience and human well-being, RDI-network structures should include a wide scope of actors and be developed so that they are based on sustainability thinking and help in directing RDI measures to networks and themes that most effectively increase regional circular economy and overall sustainability.

The mapping of regional circular economy RDI networks provides the opportunity to identify gaps in knowledge or resources and makes it possible to emulate successful network structures in similar regions. In national and international circular economy strategies, the ability to multiply good practices and identify why and how different operating and network models would fit different regions is of great value. By developing digital tools for circular economy and sustainability RDI network mapping, different development measures can be coordinated more efficiently, and overlap or discrepancy between different RDI actions can be prevented. The tools make it possible to view the development of the RDI network and act rapidly in changing development needs or operating conditions. We argue that this is necessary to bridge the gap between the results of circular economy development actions and the ambitious goals defined in the national and international circular economy strategies.

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5 SIMULATED BUSINESS GAMES AS DIGITAL PEDAGOGICAL TOOLS TO ENHANCE STUDENT LEARNING

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ABSTRACT

Simulation games are increasingly used as pedagogical tools. Simulation games improve learning outcomes through experiential and active learning among students. The purpose of this article is to systematically review the use of pedagogical methods and to understand facilitating factors in order to improve the learning outcomes in the classroom. The article utilizes a systematic bibliometric literature review to identify various predominant research themes. After analyzing the corpus, key research clusters are identified, described, and mapped thematically as motor, basic, emerging, declining, or niche. Thereafter, factors conducive to improving learning outcomes are identified by utilizing structured interviews with students who participated in a business game as part of a course. The research field has not yet proliferated, but several key themes have been identified, including active learning, business simulation, and collaborative learning. The learning objectives achieved through the implementation of simulation games are most often knowledge of business operations, immersive experience, team management, decision-making, and strategic and critical thinking. The results revealed that learning can be enhanced through familiarization of platform parameters, search, and other functions. A prior induction to the conceptual underpinning of the game drastically improves the learning outcomes.

Keywords: Business simulation, active learning, business education, business game

TIIVISTELMÄ

Simulaatiopelejä käytetään yhä enemmän pedagogisina työkaluina. Pelit parantavat oppimistuloksia opiskelijoiden kokemuksellisen ja aktiivisen oppimisen avulla. Tämän artikkelin tarkoituksena on käydä pedagogisten menetelmien käyttöä systemaattisesti läpi ja ymmärtää oppimistuloksia parantavia helpottavia tekijöitä luokkahuoneessa. Artikkelissa hyödynnetään systemaattista bibliometristä kirjallisuuskatsausta erilaisten hallitsevien tutkimusteemojen tunnistamiseen. Korpuksen analysoinnin jälkeen keskeiset tutkimusklusterit tunnistetaan, kuvataan ja kartoitetaan temaattisesti moottoreiksi, perustyypeiksi, kehittyviksi, väheneviksi tai markkinaraoiksi. Tämän jälkeen tunnistetaan oppimistulosten parantamista edistävät tekijät hyödyntäen jäsenneltyjä haastatteluja opiskelijoiden kanssa, jotka osallistuivat kauppapeliin osana kurssia. Tutkimusalaa ei ole vielä kovin laajalle levinnyt, mutta useita keskeisiä teemoja tunnistettiin, kuten aktiivinen oppiminen, liiketoiminnan simulointi ja yhteistoiminnallinen oppiminen. Simulaatiopelien toteutuksella saavutettavat oppimistavoitteet ovat useimmiten liiketoiminnan tuntemusta, mukaansatempaavaa kokemusta, tiimijohtamista, päätöksentekoa, strategista ajattelua ja kriittistä ajattelua. Tuloksista käy ilmi, että oppimista voidaan parantaa tutustumalla alustaparametreihin, hakuihin ja muihin toimintoihin. Pelin käsitteelliseen perustaan perehtyminen etukäteen parantaa oppimistuloksia merkittävästi.

Avainsanat: Liiketoimintasimulaatio, aktiivinen oppiminen, liiketoiminnan koulutus, yrityspeli

1. Introduction

There is tension in business studies between traditional linear and disciplinary focused curriculum versus holistic process-oriented pedagogy. A holistic process-oriented pedagogy is thought to better correspond with business realities. Second, it is argued that business studies should help students develop their abilities to understand the business environment in an integrative manner and make decisions in an authentic, complex, and dynamic environment which is as close to the 'real' environment as possible. Third, the constructivist view of learning views that students learn by responding to situational demands in the environment encountered. It can be expected that the learning achieved are near authentic if the learning environment is as close to the business realities as possible (Lainema & Nurmi, 2006).

Problem/project-based learning (PBL) and case studies have been used traditionally to address the above three issues in business pedagogy (Ben-Zvi, 2010). However, due to the digitalization of not only business processes but pedagogical approaches, increasingly, it is becoming possible to adopt virtual realities to better achieve these objectives. Virtual realities, specifically simulated digital business environments, can provide experiential learning to students in a realistic enough context. Thus, simulated digital environments can help students understand how several business operations are interconnected and how the trade-offs involved in decision making can impact the business performance dynamically as if it were a real-life scenario.

Several studies (Lainema & Nurmi, 2006; Ben-Zvi, 2010) are available that evaluate perceptions of business professionals or students after the use of digital simulated business games. Some of the issues addressed are how the participants experience these sessions in terms of usefulness, self-learning and whether the simulated environment corresponds to authentic business processes. However, there are some gaps in the current understanding from a pedagogical perspective. Some of the issues that require additional emphasis are the best design of the training setting, the composition of participant groups, and how to deliver the experience virtually. Additionally, most of the studies rely on self-reported assessment of the learning and lack observational data. The constructivist view of learning, in fact, emphasizes that learning should be assessed while it is occurring.

The aim of this article is to address some of these shortcomings by taking the following steps. First, the participants of the real game are students who are new to the educational system and simulation-based teaching from a cultural perspective. Second, the issues of interest were developed according to the development needs of the simulation game owner and the implementing teacher. Third, the research was focused mainly on the pedagogical and technical aspects of the game.

The main assumption of the article is that while digitally simulated business games improve learning, it is important to focus on the often-neglected component of pedagogy to design simulation settings, groups, and modes of delivery appropriately to support and enhance effective learning. The article will help assess the impact of the learning environment and mode of instruction on the learning of the participants in an experimental setting, which can prove to be valuable in determining effective pedagogical approaches to support student learning in a constructive manner.

2. Methods

There were two main methods used in this article. The first method was the systematic bibliometric review. To conduct the bibliometric literature review, 150 top-cited articles from the Web of Science (WOS) database were compiled with the keywords ("Business simulation" OR "Business game") AND ("teaching" OR "pedagogy" OR "education"). The relevance of the articles was judged after reading through the abstracts. Once the corpus of 150 top-cited relevant articles was selected, they were imported into the R software environment. The biblioshiny package (Aria & Cuccurullo, 2017) was used in the R environment to conduct the bibliometric analysis. The most important items that were examined in the program were the frequency of author keywords, the most important sources of publications and the trends in published articles. Finally, a hierarchical cluster analysis was performed on the corpus to identify the main research themes within this area resulting in 10 major themes explained briefly in the following section.

Additionally, a structured questionnaire was implemented with 40 students currently enrolled in the Post Graduate Diploma in Entrepreneurship and Startups. The students participated in the RealGame simulation game over two weeks during the summer of 2023 as part of the operations strategy course. The items included in the questionnaire survey were developed after extensive discussion with the CEO and marketing team members of the RealGame development team. Realgame (www.realgame.fi) was the business simulation tool used during the class. The questions were created in the Webropol system and implemented immediately after the end of the course during Summer 2023. After collecting the data, the thematic coding method was used to identify the most important themes from the qualitative data.

3. Bibliometric Review

A bibliometric review was conducted to identify research clusters in the application of simulation methods in pedagogy. Although the method itself is discussed in the next session, the results of the bibliometric literature review are presented here.

First, looking at the number of articles in recent years (figure 1), the research area does not seem to be proliferated. There has been a sudden spike in article production since 2018-2019. From 2020, the reason could be attributed to the extensive use of digital pedagogy methods in educational institutions during the COVID pandemic.

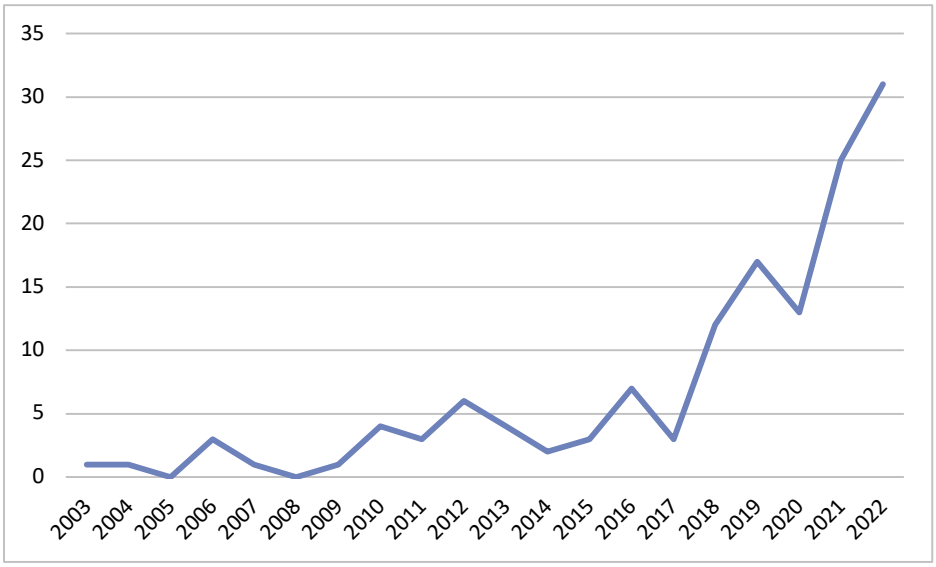

Figure 1: Annual article production in relation to business simulation pedagogy

There are several important journals focused on publications related to business simulation pedagogy. In terms of research output, as shown in figure 2, the most important sources focusing on this specific theme in descending order are: Computers & Education, International Journal of Management, Sustainability and Journal of Educational Computing Research.

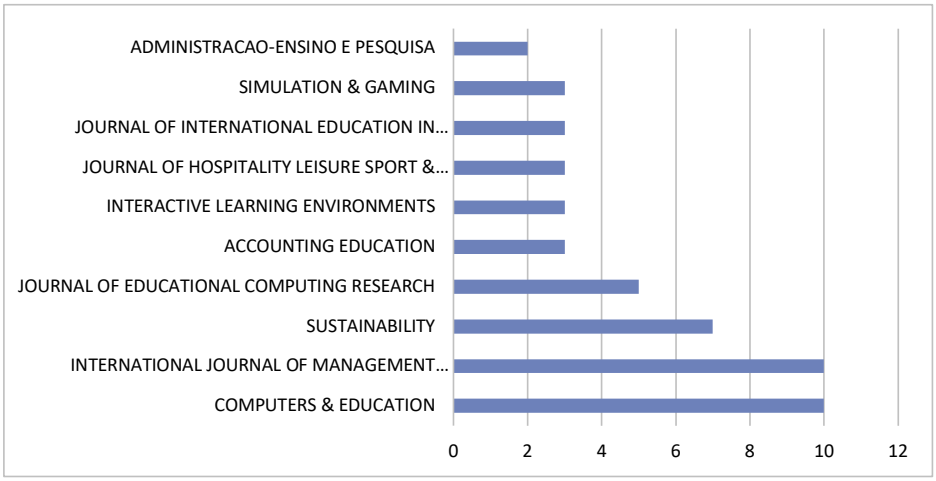

Figure 2: Most relevant sources in the field

An analysis was conducted to identify the most frequent author key words in the selected corpus. Figure 3 provides the occurrences of the most frequent key words. Only those which have more than five occurrences in the entire corpus are selected.

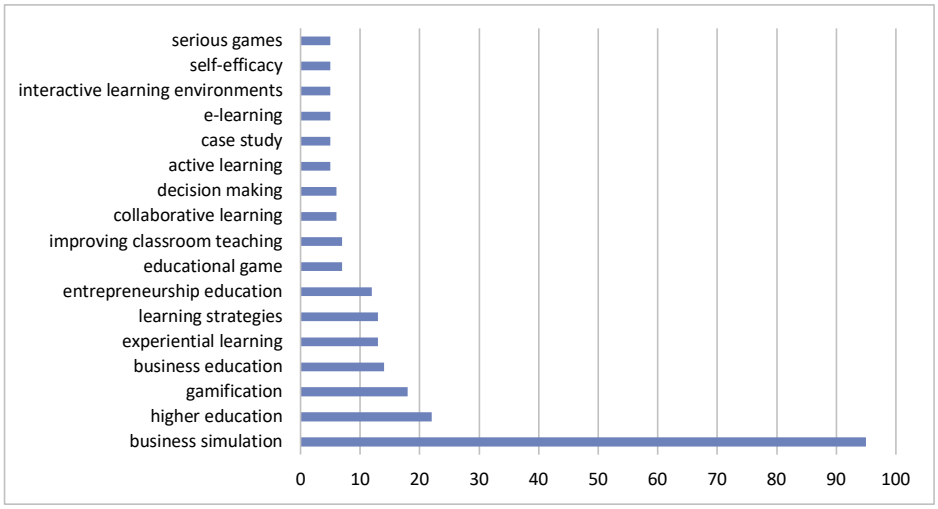

Figure 3: Most frequently occurring (>5) author key words in the corpus.

From the frequency of the key words, it was possible to identify the changing trends in their usage over time. The earliest relevant document identified was from the year 2010. Figure 4 provides the snapshot of changes in trends in the use of author key words in the corpus.

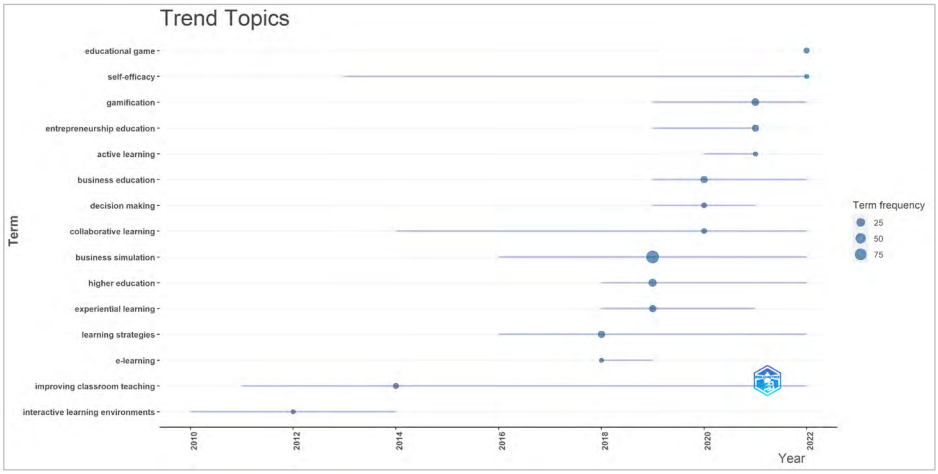

Figure 4: Trending topics in the corpus by time

Figure 4 shows that the initial emphasis on using simulation methods in teaching was to create interactive learning environments and thus improve classroom teaching. Since the year 2018, the focus has been on simulation methods as part of the e-learning strategies. The year 2019 brought about discussions concerning the use of simulation techniques in higher educational institutions, particularly focusing on the business field. Simultaneously, perhaps due to the ubiquity of online teaching and less frequent in-person teaching, simulation methods are considered as an avenue to improve experiential learning.

Since 2020, the focus on simulation pedagogy has shifted towards improving student decision-making and fostering collaborative learning in business education. During 2021, the trend shifted towards gamification pedagogy, where conceptual learning occurs through active games. Even within the business field, gamification as an active learning method is emphasized in entrepreneurship education. Recently, several research articles discussed the psychological concept of self-efficacy and its relation to simulation pedagogy. The major thrust of the research is in identifying the development of self-efficacy in participants through simulation games as these games can improve the participants' belief in their ability to take actions leading to specific performance attainments. This is what is assumed to occur naturally while students participate in business simulation games. Recent years have seen interests in development of educational games using simulation methods, not only in the business field but also other bodies of knowledge and contexts.

After conducting the analysis regarding the literature on use of business simulation in the educational context in the biblioshiny package (Aria & Cuccurullo, 2017) in the R software environment, several research clusters were identified in the corpus. Some of the themes identified were: active learning (11 documents); business education (24 documents); business simulation (48 documents); data mining (2 documents); distance education and online learning (2 documents); gaming (2 documents); improving classroom teaching (11 documents); innovation (2 documents); self-efficacy (10 documents); serious games (7 documents); sustainability (3 documents); system dynamics (1 document); teamwork (3 documents); and technology acceptance model (4 documents). Due to the very few cited sources within the clusters, five themes, data mining, distance education, gaming, innovation, and system dynamics, were collapsed into the "rest" category. Valuable information is lost through this procedure, but it helps to collapse the research themes into unique and manageable clusters. It should be noted that this study adds more research clusters in comparison to some bibliometric review already published (Nguyen & Hallinger, 2020).

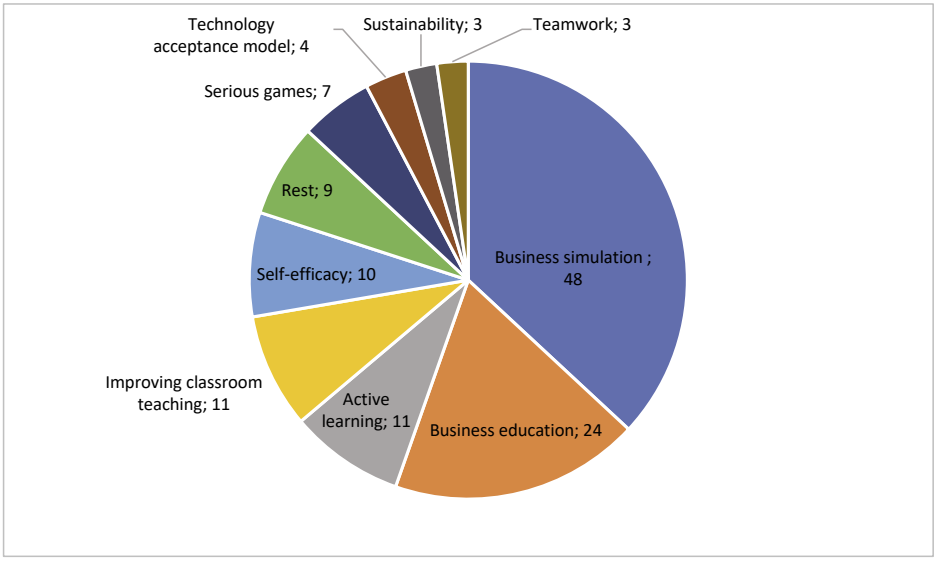

Figure 5: Research clusters identified in the corpus with a number of sources.

4. Major Research Themes

4.1 Simulation in Business Education

Most business games deal with the management of economic processes as a business. Such games are implemented in sub-disciplines of business administration including strategic management, marketing, finance and accounting, economics, product innovation, and entrepreneurship. Business simulation games focus on developing critical thinking skills by associating business concepts in a real business context, albeit in a virtual environment (Zulfiqar et al., 2018). Business simulation methods are primarily utilized in entrepreneurship education as they enhance critical entrepreneurial skills in critical thinking, team collaboration, time management, and entrepreneurial intention while providing a risk-free environment to test business decisions in various scenarios. In contrast to regular theoretical lectures, entrepreneurial intention among students is higher when simulation games are used as a teaching methodology (Zulfiqar et al., 2021). One important predictor of the learning effectiveness of a simulation game is how the simulated model fits with the real-world business environment. The better the model-reality fit, the better the learning effectiveness (Wei et al., 2022).

4.2 Active Learning

This theme is based on the premise that lecturer and case teaching may have little real-life applicability, and students learn better only after performing empirical tasks (Ben-Zvi, 2010). Simulation methods improve the ability of students to relate abstract conceptual terms to a real-world environment. Such methods could be categorized as "action learning" or "active learning". Within the field of logistics and information systems, the role of action learning in achieving learning objectives is important and is enhanced through business simulation games (Lau, 2015). Active learning methods are shown to provide an immersive experience where learning is more concrete and personal (Jagger et al., 2016). Further, the measured student engagement levels while using simulation games are higher in comparison to traditional case study methods (Rogmans & Abaza, 2019). Some researchers also refer to the pedagogy based on the combination of simulated environment in lieu of real-world planning in a realistic environment as "experiential learning" (Angolia & Pagliari, 2018).

4.3 Improved Classroom Teaching

Some articles focus on the use of simulation methods to improve overall classroom teaching. For example, it has been suggested that simulation methods should be used as early as possible as part of the curriculum to improve the foundational understanding of concepts (Angolia & Reed, 2019). Simulation methods are thought to be effective as they have a positive effect on cognitive and affective learning outcomes, which have a subsequent impact on critical thinking skills (Gatti et al., 2019). Many of the tenets of constructivist learning theory, which view that students construct new knowledge based on their own previous conceptual knowledge, are supported using simulation methods as it provides a risk-free environment to make decisions (Zulfiqar et al., 2018). In effect, simulation games not only help to develop the cognitive skills of the students, which are largely substantive knowledge, but they also help in the development of non-cognitive competencies such as entrepreneurial attitudes (Costin et al., 2019). Beyond the substantive aspects of the curriculum, simulation-based pedagogy is thought to enhance decision making abilities, teamwork and communication skills, and overall readiness for future employment (Cox, 2018)

4.4 Self-efficacy

There is no doubt that students' motivation to learn has a significant effect on the achievement of learning outcomes (Gatti et al., 2019). Especially in entrepreneurship education, students' attitude and intention to engage in entrepreneurial activities is influenced by their

motivation to learn about entrepreneurship in general. This is a phenomenon that some researchers also refer to as "entrepreneurial self-efficacy" (Yen & Lin, 2022). Simulation games have positive effects in improving the motivation of students and thus the attitude and intention to engage in entrepreneurial activities (Zulfiqar, Sarwar, & Khan, 2018). Similarly, a study (Palmunen et al., 2021) suggests that simulation games improve the decision-making abilities of managers by helping to develop accurate mental models due to high-quality heuristics developed while playing the game.

4.5 Serious Games

The scope of simulation games in the use of different knowledge domains is expanding. There is evidence of the use of simulation methods in teaching hotel revenue management (Cox, 2018). Innovative case study methods, in combination with simulation methods, have proved effective in training future veterinarians (Veremeeva, Krasnolobova, & Goncharenko, 2022). Teaching business language through the combination of role playing and simulation games has been found to be effective (Dovzhenko et al., 2023). A combination of case studies, project tasks, and simulation games has been shown to be effective in training PR professionals (Kyrychok, 2021). The main idea of this theme is that customized and advanced simulation games in teaching various domain-specific knowledge are expanding drastically, which could all be categorized as "serious games". The issue of interest in this theme is not only in developing domain-specific games but also in developing appropriate backend processes, architecture, and platforms for the dissemination of serious games.

4.6 Technology Acceptance Model (TAM)

Researchers have tried to understand how playing business games can lead to behavioral changes in students, such as developing a positive intention toward entrepreneurial activities. One of the most common frameworks used to explain the changes in behavior due to the adoption of a certain technology is the TAM model (Zulfiqar et al., 2018). The framework suggested by TAM is particularly important in integrating simulation games into entrepreneurship education because it shows that the perceived value of simulation games by the participants influences their attitude toward entrepreneurship and, subsequently, their entrepreneurial intention. Thus, TAM can provide a framework to explain factors that affect students' intention to use the simulation games in the first place. Some of the influencing factors behind students actively intending to use simulation games are the amount of effort required, social influence, expectations for performance, pleasure, and other facilitating conditions (Wang et al., 2019). As a result, teachers can focus on these issues before implementing simulation games to influence the students' usage intention.

4.7 Sustainability

The nature of the simulation games could be different according to the learning objectives. Sustainability has been one of the areas in businesses where simulation methods have found relevance. Education for sustainable development (ESD) has been increasingly emphasized. A combination of action and experiential learning has been shown to be effective, hence the use of simulation games in ESD (Gatti et al., 2019). For example, a game called "Sustainability Manager" has been used to train students and executives in sustainability management (Baumgartner & Winter, 2013). Similarly, there is evidence of 3D immersive games used to improve business ethics education through visual case models (Jagger et al., 2016).

4.8 Teamwork

All meaningful learning experiences are embedded in social experience. When teams are making decisions in simulation games, there is continuous problem-solving in a social setting, which can enhance meaningful learning (Lainema & Nurmi, 2006). Group work is a common teaching method used in business education; however, it should be distinguished from what is referred to as authentic team-based learning (TBL) (Lohmann, et al., 2019). Simulation methods are shown to contribute to learner satisfaction and enhance learning goals in a social setting by providing an authentic TBL environment. The hallmark of an authentic TBL is to provide a constructive environment to facilitate social learning. However, it should be noted that an authentic TBL is created when it is supported with instructor guidance and developed accountability measures in the team (Oosthuizen et al., 2021).

4.9 The Classification of the Major Themes

From the bibliometric review, it was possible to categorize research clusters in terms of the degree of development and relevance. Based on these dimensions, the clusters were classified as shown in Figure 6.

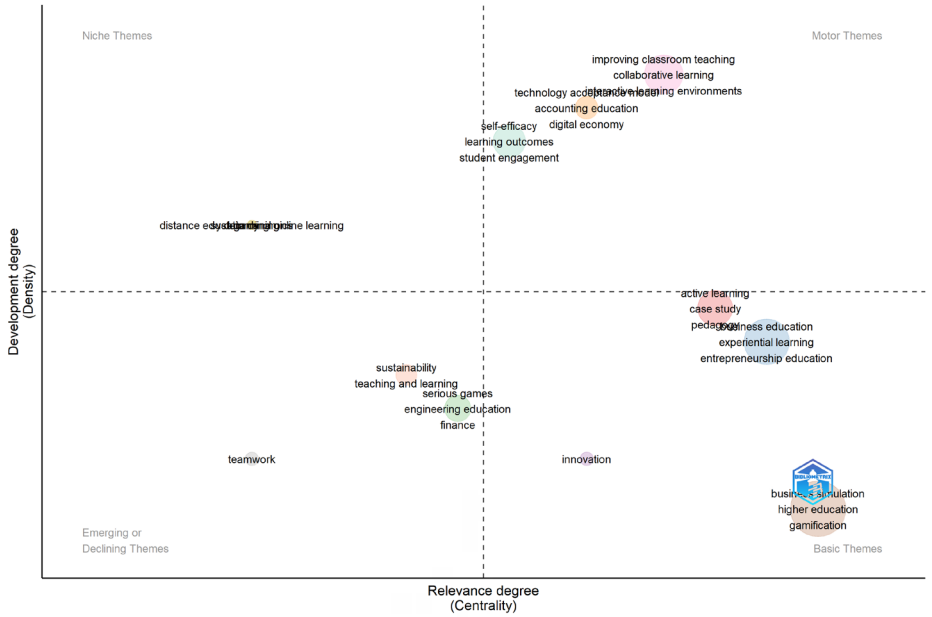

Figure 6: Thematic map of the research clusters

Figure 6 classifies the clusters into four quadrants: basic themes, motor themes, emerging or declining themes, and niche themes. Themes such as "distance education", "online learning" and "gaming" are niche themes within the area of this research. These are issues that are highly specialized areas of research but are peripheral to the main research area and may not exhibit high relevance to the field. "Teamwork" in business simulation games is a declining theme, whereas "sustainability" and "serious games" are emerging themes in the research field. "Business education/simulation," "experiential learning," "entrepreneurship education," "gamification," and "active learning" are some of the common themes in this area, which are important for the field of research but are still not well-developed. Relevant areas of research that are driving the research in this field are issues such as "collaborative learning," "improving classroom teaching," "technology acceptance model," "self-efficacy," and "student engagement." Future researchers should be aware of this classification to develop their own research by identifying research gaps in contemporary research.

5. Results

5.1 Survey Participants

Altogether, 40 students participated in the structured interview, of which 60 % (24) were female and 40 % (16) were male. 95 % (38) of the respondents were 26 or above, and the rest (2) were between 22-25 years. Most of the students are from a single country and studying in the Post Graduate Diploma program.

Only 17 % (7) of the respondents were introduced to simulation games for learning business strategy concepts during their previous studies. Out of them, only 71 % (5) have used it regularly, in contrast to the rest (29 %), who use it only occasionally. Almost 90 % (36) of the participants were excited when they were first introduced to the business simulation game for operations strategy learning, and the rest were either "indifferent" or even "apprehensive".

5.2 Program Benefits

There were several benefits highlighted by the participating students. Most of the participants focused on **knowledge of business operations,** which was indeed the main emphasis of the course. It helped students to understand the genuine working environment of a business. Indeed, one of the participants mentions that: *"Instead of just learning complicated textbook definitions, the simulation games help us understand the practical side better and in a much more realistic way"* [sic]. In addition to understanding functional strategies such as supply chain management, the students also improved their skills in analyzing competition and conducting marketing research. More conceptually, students referred to the development of their cognitive abilities.

In addition, most of the participants focused on the **immersive experience** of business operations. As one participant mentions: *"It's a game, but when you know the basics and how to, where to start and control the things, etc., as per my playing experience, at one point, I forgot that I am playing. I realized as I'm into one real business and I'm interacting with my team members with techniques and ways to improve and manage the business"* [sic]. The immersive experience of real-world business was emphasized by other participants by using concepts such as "hands-on experience", "running a real company", "understanding the market problem in real-time", "real world learning", "experiential learning", "game-based learning" and so on. The immersion in the simulated program of real-world businesses was an important addition for many of the participants in contrast to the traditional theory-based pedagogy, often implemented through lectures. Conceptually, students refer to the concept of "active learning".

Several participants focused on the **team management skills** that were developed. Within this, many participants focused on the need to genuinely engage with their teammates to extend their critical thinking and problem-solving capabilities to experiment with different strategies in real time according to the changing business realities. Interaction among the group members is vital to improving and managing the business and, consequently, winning over competing teams in a real-life setting. Coordination and cooperation among the team members are essential in succeeding in the game. Different team members had to assume the roles of procurement manager, production manager, marketing manager, and managing director and communicate plans, forecasts, and estimates to achieve agreed-upon business KPIs. Additionally, a few participants reflected that it helped them to develop their leadership skills as it was important for someone to lead the team to control the business operations and achieve the desired objectives. Since one of the required aspects of the game is to make decisions in a rapidly changing scenario, it is vital to consider time as a resource and learn to allocate responsibilities and manage time well in a team. Conceptually, students refer to authentic Team-Based Learning (TBL).

Another key benefit focused on by the participants was enhanced **decision-making abilities**. The ability to understand that business operations, such as production and distribution, can be improved by learning and implementing the rules of the business properly. In turn, this increases the role of proper decision making in succeeding in business. Since the simulated hours speed up real-world time, there is less lag in decision-to-result timeframe. This shows that decisions made in real businesses have "real" consequences. Not only that, for a similar reason, it is of utmost importance to be able to make rapid decisions in "real time" among team members as the consequences would be immediate. What the students refer to here conceptually is the development of their entrepreneurial self-efficacy.

Overall, engaging with the program developed the participants' **strategic thinking** abilities as it required a concrete understanding of Key Performance Indicators (KPIs) and proper ex-ante and ex-post analysis to develop strategies with a view to excel at those KPIs. Not only that, but some participants also reflected on the need to consider developing back-up plans in case the main decisions made would fail. Students developed the ability to think about several strategic options beforehand to analyze the consequences of each specific decisions.

From a pedagogical perspective, most of the students viewed using simulations in teaching as engaging and enjoyable. It is an exemplary setting for experiential learning and helps in retaining useful substantive knowledge through engagement. Whereas it is hard to focus on lectures or textbook material continuously for several hours, in the game, it is easier. Particularly, since some of the participants did not have a business background, the game provides an environment to familiarise themselves with business operations well. In terms

of usability, the simulation programs are easy to learn and use. As the platform provides possibilities to experiment with various strategies in real time, it promotes **creative and critical thinking**. In fact, 80 % (32) of the respondents viewed that it helped them better understand the operations strategy related concepts compared to traditional teaching methods, and 17 % (7) of the participants thought that it was better only to some extent. The majority (97 %) of participants believed that it improved their problem-solving skills related to operations strategy challenges. Some students reported that the program helped to develop their entrepreneurial skills.

5.3 Pedagogical Improvements

The participants suggested some ways to improve teaching. The significant challenge for many was the lack of holistic understanding of the gaming system, which, in effect, means that a detailed induction is required at the beginning to familiarize participants with the functions of the game. Specifically, it is necessary to make clear the **platform's interface,** and various parametric adjustments are made at the system level over time so the participants can adjust their decisions as they play the game.

Another challenge in playing the game successfully is not having a sufficient **conceptual or theoretical understanding** of the business processes. This suggests that it is vital that the game is part of a course where the associated business principles are introduced before starting the game. When a participant does not understand how all the operations are linked to each other, it is difficult to make any decision well. For some participants, it was difficult to relate the KPIs of businesses to specific business decisions, and it was helpful to explain these issues at the beginning.

From the teacher's perspective, team management is essential to achieve the learning objectives. Clear roles among team members and responsibilities, including the amount of time needed, should be clarified at the beginning.

Many participants suggested that the idea of simulation games could be integrated into other parts of the business curriculum to enhance the learning experience. In addition to operations management, the game could be implemented in marketing management courses. Overall, the idea is that in other courses, similar kinds of immersive, practice-oriented games could be included to enhance real life learning. In various programs, integrating RealGame as a recurring interactive module would provide ongoing opportunities to apply business-related concepts, fostering continuous skill development and deeper understanding, complementing traditional lectures, and enriching the learning journey. As the students

perceived it to be an interesting way of learning, these types of stimulations could be integrated into various courses within different topics. It could be used for group projects, case studies, or individual assessments to simulate real-world business challenges.

Previous research confirms the findings reported here. For example, a meta-review of good instructional practices in simulation-based teaching was identified to be preparing the students well, encouraging students to reflect on their decisions, providing adequate coaching and mentoring to students, fostering collaborating learning and engagement, proper team structures and didactic interventions (Scholtz & Hughes, 2019).

5.4 Suggested improvements in the gaming system

Based on their experiences, participants also suggested several methods to improve the simulation system itself. For example, the Bills of Materials (BOM) of different raw materials could be more intuitive. The filtering options in the platform interface could also be more user-friendly. In some cases, when faced with time pressure, it is necessary to be able to focus only on vital information rather than trying to find the essential information from the clutter of information visible in various platform interfaces. However, in true business scenarios, it may be argued that segregating core information from the available clutter is a key skill to be learned.

The messaging system is introduced in the system when some decisions must be made, such as when delivery is due. The platform could be improved by adding a voice alarm system to warn about critical operations, such as when the inventory is reaching zero. Some sort of voice system was suggested by more than one participant. This function could prove to be useful when making decisions under time pressure. Related to this functionality, some participants also suggested voice messaging systems among the team members within the team, especially when the various participants are working together remotely.

A demo version of the game, where the students can practice before the start of the simulation, could be introduced. Further, adding functions and parameters in the game, such as the ability to buy out other businesses, could be beneficial. The ability to communicate and develop collaborative strategies with other teams competing in the game would be good. In addition to playing with given products to be manufactured on the same production line, instead of shifting production, it could be more engaging to add multiple production lines. Other customizations in the capacity of the warehouse could also be reexamined. Some participants also felt that there is a lag in updating the data according to the decisions made, which could be improved, although this is also reflective of real-life situations. Similarly,

although the recently updated version of the game has improved the game's appearance and graphics, this was also suggested as a point for improvement.

6. Conclusion

This study focused on the use of simulation games in business pedagogy. The article examined two major themes. First, it was necessary to map the current research field in terms of the relevant areas of interest in business pedagogy using simulation methods. Second, the study aimed to understand the conducive factors to enhance learning outcomes in a classroom setting after implementing a simulation game.

The bibliometric review identified that this research area is not yet proliferated. Some of the major themes explored in this area are business simulation, active learning, improving classroom learning, self-efficacy, serious games, TAM, sustainability, and other minor themes. Among these, some of the themes were well-developed and integral to the research area, whereas other themes were peripheral, not well-developed, or emerging/declining themes.

The structured questionnaire implemented to the participants of the business simulation game revealed several important issues regarding the conducive learning context. The benefit of the program supports the findings of the literature review. After the thematic analysis of the structured questionnaire, the most important benefits highlighted by the students are knowledge of business operations, immersive experience, team management, decision-making, and strategic and critical thinking. The users also suggested key improvements in the learning context. Some of the pedagogical improvements suggested were conceptual readiness, induction to the platform architecture, appropriate accountability measures in the teams, and more holistic integration in the business curriculum.

RealGame is largely focused on operational strategy and supply chain management. Based on similar gaming logic, it is possible to develop business games focused on customer relationship management and sales strategy. For example, it is possible to develop a business game that simulates the customer base and relationship management based on parameters such as marketing channel expenditure, acquisition and churn rate, and customer lifetime value. Using the logic of traditional sales funnel, and the parameters such as target segment size, prospective value, and conversion ratio, it is possible to develop a business game that simulates sales management. It is safe to assume that business games are already using similar logic or are under development, but they are not already widely used in the pedagogical context. Future research could focus on observation methods to understand how participants make decisions *during* the game rather than discussing a retrospective

understanding of the game. Eye-tracking devices and other neuroimaging tools could be used as observational methods to understand more deeply the psychological factors affecting decisions made. Some sort of experimental study with two distinct groups differentiating by the intervening variable of interest could be designed to understand whether certain variables of interest influence the performance of certain KPIs. It is quite clear that it is possible to develop additional games within other sub-disciplines of business and conduct studies using innovative research designs to understand the psychological underpinnings of decision-making. It seems like applying simulation methods to improve teaching in the classroom context is only beginning in earnest.

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6 MICRO-CREDENTIALS IN HIGHER EDUCATION – TOWARDS A COMMON EUROPEAN UNDERSTANDING

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ABSTRACT

Fast and flexible digital education offerings have been taking over the skills and competence development scene in recent years. Traditional education institutions and private companies are providing new forms of education, training, awards, and certifications in all sizes and shapes to meet the rapidly changing skills-development needs of the labor market. The focus has shifted from macro-credentials (degrees) to micro-credentials. This essay opens the concept of micro-credentials at the European level and contributes to the current discussions on micro-credentials in higher education. In June 2022, the Council of the European Union gave the EU Member States a Recommendation on a European approach to micro-credentials for lifelong learning and employability. The Recommendation provides a common definition, standard elements, and principles for design and issuance to boost common European understanding and to make micro-credentials a commensurate and trusted way of credentialing (digitally) these smaller units of learning outcomes. While comprehensive, the Recommendation also leaves room for interpretation and speculation, especially considering the practical implementation processes in educational institutions. In any case, to harness the possibilities of micro-credentials, strategic considerations need to pay attention to all the relevant stakeholders.

Keywords: micro-credentials, higher education, digital credentialing, European Union

TIIVISTELMÄ

Nopeasta ja joustavasta digitaalisesta koulutustarjonnasta on viime vuosina tullut tärkeä osa osaamisen kehittämistä. Sekä perinteiset koulutuksenjärjestäjät että yksityiset yritykset tarjoavat monenlaista koulutusta, valmennusta, todistuksia ja sertifikaatteja vastatakseen työmarkkinoiden nopeaan osaamisen kehittämisen tarpeeseen. Painopiste onkin siirtynyt tutkinnoista pienempiin osaamiskokonaisuuksiin.

Kesäkuussa 2022 Euroopan Unionin Neuvosto antoi EU:n jäsenvaltioille suosituksen eurooppalaisesta lähestymistavasta pieniin osaamiskokonaisuuksiin elinikäisen oppimisen ja työllistettävyyden tukemiseksi. Suositus tarjoaa yhteisen määritelmän, vakiotiedot ja pienten osaamiskokonaisuuksien suunnittelun ja myöntämisen periaatteet buustatakseen yhteistä eurooppalaista ymmärrystä pienistä osaamiskokonaisuuksista, ja tehdäkseen pienistä osaamiskokonaisuuksista yhteismitallisen ja luotetun tavan todentaa (digitaalisesti) näitä oppimiskokemuksia.

Vaikkakin kattava, suositus jättää myös tilaa tulkinnalle ja spekulaatiolle, erityisesti kun tarkastellaan käytännön toteutusprosesseja. Jotta pienistä osaamiskokonaisuuksista saadaan irti kaikki niiden tarjoamat mahdollisuudet, tuleekin asiaa lähestyä strategisesti, huomioiden kaikki keskeiset sidosryhmät.

Tämän esseen tarkoituksena ei ole tarjota kattavaa kuvausta tai analyysia pienistä osaamiskokonaisuuksista, vaan avata käsitettä Euroopan tasolla, ja olla osallisena ajankohtaisessa keskustelussa pienten osaamiskokonaisuuksien roolista korkeakoulutuksessa.

Avainsanat: Pienet osaamiskokonaisuudet, korkeakoulutus, digitaalinen todentaminen, Euroopan Unioni

1. Introduction

Traditional higher education degrees provided by trusted education providers are considered proof of competency for the job market. However, the rapid changes within the labour market make lifelong learning and development of skills and competences a necessity for most in order to keep up with the pace of development. Macro-credentials, i.e., higher education degrees, cannot provide the answer to the constant demand for skill and competent renewal and development because they are too slow, too rigid, and too expensive. A degree, after all, can take many years to complete. To meet the needs of the labour market, there has been

an explosion of learning opportunities and providers, as well as new ways of awarding and credentialing the learning outcomes of a variety of short and tailored courses and learning provisions. Micro-credentials are not a new phenomenon, but their importance in re-skilling and up-skilling the workforce has become globally an important policy topic in the last few years (Brown et al., 2021). More attention has also been paid to non-credentialed on-the-job learning and other nonformal and informal learning.

The proliferation of courses and credentials has led to huge variations in depth and breadth as well as in education quality and certifications. Thus, in June 2022 the Council of the European Union issued the European Union (EU) Member States a Recommendation on a *European approach to micro-credentials for lifelong learning and employability*. Together with the Digital Education Action Plan 2021-2027, the Recommendation envisions a future of flexible, accessible, learner-centered, and high-quality digital education in Europe. (European Commission, 2022, 2020). The Recommendation provides a much-needed, yet still somewhat vague, definition of micro-credentials at the European level: "Micro-credential' means the record of the learning outcomes that a learner has acquired following a small volume of learning." The definition also includes other criteria, such as being owned by the learner, being assessed with transparent and clear criteria, and being made stand-alone or combined into larger credentials, even degrees. (European Commission, 2022: 13).

The Recommendation leaves many open questions for Member States, education providers, and other stakeholders to solve. This is potentially problematic if national-level interpretations and implementation processes become too versatile. This would lead to a situation where the well-intentioned European-level recommendation would not meet its purpose of giving a common framework for micro-credentials but lead to an incoherent set of education provisions instead. In that case, there would be no change to the status quo other than a new concept or category introduced, potentially confusing stakeholders even more. On the other hand, in the best-case scenario, micro-credentials would earn the respect of all relevant stakeholders.

This essay will explore the implication of the European-level recommendation and the ongoing and versatile discussions around micro-credentials, mostly at the higher education level. If a common European understanding of micro-credentials is the goal, what are the key questions that still need answering? What should be considered in Higher Education Institutions to unveil the full potential of micro-credentials as described in the Recommendation?

First, the data sources will be presented shortly. Second, the Recommendation is introduced, describing first its connection to European development directions and secondly unwrapping its three core elements: 1) Definition, 2) Standard elements, and 3) Principles

of design and issuance. Third, an overview of topics related to achieving a common European understanding of micro-credentials will be investigated. Finally, some concluding remarks will be offered.

2. Methods and Data

This article is based on EU documents and publications as well as recent research articles, the method is close reading. Micro-credentials, as an emerging global phenomenon, are subject to a lot of research publications. The research articles selected are some of the most recent ones or otherwise considered relevant for the questioning described in the previous section.

Many of the heuristic reasoning and visioning presented in this essay are based on the observations and discussions in the European Digital Education Hub (EDEH) Micro-credentials working group, in which the writer is a member. The goal set for the working group was to explore the best way to realize and implement the Recommendation. There are members from 16 countries and various educational contexts as well as public, non-governmental, and international organizations in the working group. (European Commission, 2023b).

3. A European Approach to Micro-Credentials

The need for continuous reskilling and upskilling of the workforce to secure a future-oriented and responsive labor market is widely recognized and promoted globally. This has led to the emergence of accessible, learner-centered, and flexible education offerings, i.e., shifting the focus from formal degree education to shorter, modular, and more innovative entities. To be able to face the ever-accelerating pace of change, sped up by the COVID-19 pandemic but especially by the green and digital transitions, also requires new, innovative, and even somewhat disruptive thinking in the higher education policy (Varadarajan et al., 2023). The role of higher education institutions (HEI) must be rethought in a situation where new, more precise, and current skills acquisition needs and policy-level expectations are aligned with degree education tradition, which emphasizes deeper and broader knowledge-building and academic endeavors (Marginson, 2023).

The idea of micro-credentials is not new. In fact, different short educational and training offerings leading to an award or a credential have been a vital part of education for decades. Micro-learning, micro-courses, MOOCs, nano/micro-degrees, digital badges, and so on have become a practical and popular way to continue skills development, mostly in digital environments. However, a common lexicon and understanding of these small volumes of

learning have been lacking. A variety of labels or descriptions have hindered the acceptance of micro-credentials as an alternative for or complementary to degree education and/or as trusted evidence of learning outcomes, skills, and competences (Bideau & Kearns, 2022: 2).

A core element of the European Higher Education Area (EHEA) is common criteria and standards for education to enhance coherence and interoperability among European higher education institutions and make European higher education more attractive and competitive globally[2]. The most known implication of the standards would be the European Credit Transfer and Accumulation System (ECTS), which has established a common foundation for higher education in Europe. These standards have not existed yet for micro-credentials, but as stated in the EHEA 2020 Roma Ministerial Communiqué (European Higher Education Area, 2020), a common understanding of micro-credentials would support the vision for a more innovative, inclusive, and interconnected European Higher Education Area. In addition, a common understanding and criteria would help to build the value and recognition of small volumes of learning for all the stakeholders.

Hence, in June 2022, the Council of the European Union issued the Member States a Recommendation on micro-credentials for lifelong learning and employability to address the lack of a common European understanding of micro-credentials (European Commission, 2022). The objective of the Recommendation is:

> *"a) enabling individuals to acquire, update and improve the knowledge, skills and competences they need to thrive in an evolving labour market and society, to benefit fully from a socially fair recovery and just transitions to the green and digital economy and to be better equipped to deal with current and future challenges;*
>
> *b) supporting the preparedness of providers of micro-credentials to enhance the quality, transparency, accessibility and flexibility of the learning offering in order to empower individuals to forge personalised learning and career pathways;*
>
> *c) fostering inclusiveness, access and equal opportunities and contributing to the achievement of resilience, social fairness and prosperity for all, in a context of demographic and societal changes and throughout all phases of economic cycles."* (European Commission, 2022: 11)

[2] See, https://www.ehea.info/

The Member States were expected to implement the Recommendation as soon as possible and inform the European Commission (EC) by December 2023 of the corresponding measures supporting the objectives of the Recommendation in each Member State.

The Recommendation implements many of the EC priorities for 2019-2024, such as "A Europe fit for the digital age" and "An economy that works for all." Besides European Skills Agenda,[3] one of the key linkages is to the European digital identity development, more specifically to European Digital Identity Wallet and underlying Architecture Reference Framework,[4] which would enhance many of the Recommendation aims by enabling European level digital credentialing and interoperability, and principles such as portability and being owned by the learner.

EC policy official O´Keeffe (2023) envisioned that in the future, there will be "a new currency of micro-credentials," which can be stored in the EU digital wallet (see also Chakroun & Keevy, 2018). In addition to solving the technical questions on micro-credentialing, there is a need to improve awareness, value, and recognition of micro-credentials for different stakeholders. To support both these aims, the Recommendation includes a list of common European standard elements to describe micro-credentials. These elements are also to be included in the European Learning Model (Launch of the European Learning Model - A New Step for Interoperability in Learning, n.d.). The common data model will, in addition, support, for example, the development of the European Education Area by enabling interoperability and easier exchange of data.

The Recommendation consists of three vital elements:

1) definition of a micro-credential,
2) standard elements,
3) principles of design and issuance.

We will explore these core elements in the following section.

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[3] Full text, https://ec.europa.eu/social/main.jsp?catId=1223

[4] Full text, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-digital-identity_en

4. The Definition of a Micro-Credential

4.1 The Micro-Credential Recommendation

With the Recommendation, the Council of the EU is taking a stance on micro-credentials within the European Union. They state that not every small learning provision should be labeled as a micro-credential if they do not meet the definition and standards. However, it is important to acknowledge that the concept of micro-credentials is used globally, and the definition does not apply worldwide, i.e. outside of Europe (Brown et al., 2023; McGreal & Olcott, 2022)policy-makers and educational leaders are giving to micro-credentials by framing the discussion in several recent high-level policy developments, an exponential growth in the number of academic publications and the increasing level of interest shown by popular media. It follows that micro-credentials appear to be high on the change agenda for many higher education institutions (HEIs. The European definition is, anyways, well-aligned with the UNESCO definition (UNESCO, 2022)

A micro-credential is defined in the Recommendation, as:

> *... the record of the learning outcomes that a learner has acquired following a small volume of learning. These outcomes have been assessed against transparent and clearly defined criteria. Learning experiences leading to micro-credentials are designed to provide the learner with specific knowledge, skills and competences that respond to societal, personal, cultural or labour market needs. Micro-credentials are owned by the learner, can be shared and are portable. They may be stand-alone or combined into larger credentials. They are underpinned by quality assurance following agreed standards in the relevant sector or area of activity.* (European Commission, 2022: 13)

Many of the statements in the definition are addressed in more detail in the standard elements or especially in the principles of design and issuance, which will be explored in the following sections. However, a few remarks on what is left unsaid will be considered next.

The Recommendation states in the first sentence that micro-credential is the record of learning outcomes, and the following sentences broaden the conceptualization with more qualitative features. These features, such as assessment against clearly defined criteria or responding to specific needs, leave considerable room for interpretation. For example, are criteria defined clearly enough? Or, who decides what the specific needs are that micro-creden-

tials must respond to? When finding an answer to these open-ended questions, the member states and/or education institutions define the final implications of the Recommendation.

Micro-credentials are linked to digital credentialing even if the matter is not addressed in the definition because they are stated to be owned by the learner, shareable, and portable. The Recommendation does not exclude any other forms of credentials, such as paper prints, but any other than digital credentialing would make following the principles nearly impossible and would prevent accomplishing the higher policy aims of the EU.

The definition does not take a stance on how learning is organized either, even though the discussions and development of micro-credentials are connected to digital transformation and online learning (Salama & Hinton, 2023: 917). The focus is anyways on learning outcomes, not on skills acquisition. To obtain a micro-credential, the learning outcomes always need to be assessed against transparent criteria. How the learning outcomes are reached is irrelevant. Learning outcomes can, of course, be obtained in specific formal courses leading to a micro-credential, but informal and nonformal learning becomes a valuable and recognized way of obtaining learning outcomes. This raises the issue that actual assessment and validation of learning outcomes is on focus, which forces us to expand or rethink the way we might comprehend the role of a Higher Education Institution (HEI). What if the key is to recognize, assess, and validate competence acquired in and outside of formal education, not just to design and implement learning offerings? What should we then be focusing on, on developing the ways we assess and set criteria (preferably together with the working life partners) or designing and implementing formal courses and learning materials leading to a micro-credential?

The Recommendation does not define what is a "small amount of learning" either. For different education providers, it will mean different things, which might diminish the value of micro-credentials if "small amount" is defined in very different ways. For higher education institutions, the use of the European Credit Transfer and Accumulation System (ECTS) also applies to micro-credentials, as described in the standard elements later. This is in part, due to the commitments in the Bologna Process. The use of ECTS provides an understandable and recognizable system and a tool to describe the amount of learning. (Directorate-General for Education, 2015). In fact, in the European Higher Education Area (EHEA) the possible range of ECTS in micro-credentials is between 1 and 59 ECTS (1 ECTS = 28 hours of study), although it is expected that most micro-credentials will be much smaller, possibly from 1-15 ECTS (Microbol, 2022, p. 9). In any case, the range between ECTS provided will be considerable.

4.2 Standard Elements of Micro-Credentials

The standard elements of a micro-credential include both mandatory elements and optional elements. Optional elements can be used when relevant. Mandatory elements are a basic description of the data provided. Besides the obvious elements concerning the learner identification, the issuer (such as country and awarding body), and the micro-credential (such as title, date of issuing, and level of the learning experience in ECTS), the mandatory elements emphasize the role of learning outcomes, assessment, and quality assurance (QA). Although the form of participation in the learning activity is to be addressed, the standard can be appraised by taking a step towards more skill and competence-based education. (European Commission, 2022: 27).

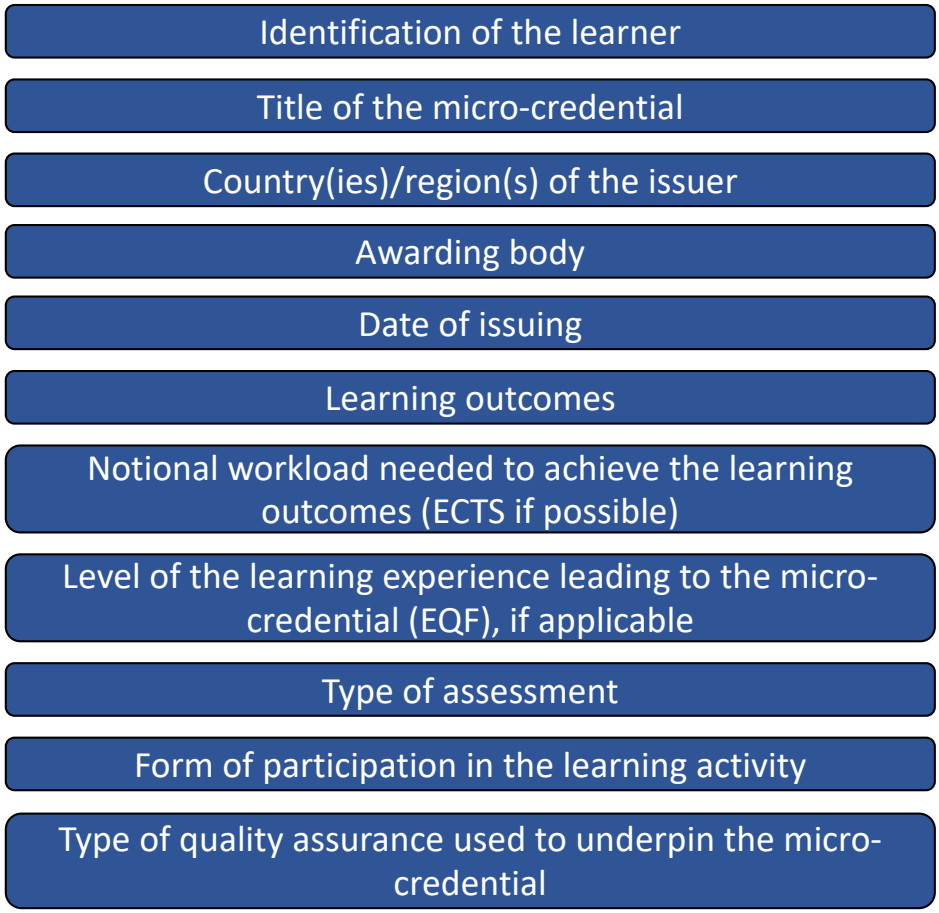

Figure 1. The European standard elements to describe a micro-credential (European Commission, 2022: 16)

Optional elements can be added if relevant. The list is not comprehensive and includes such elements as prerequisites needed, grade achieved, and stackability options. Stackability options mean that micro-credentials can be offered as stand-alone, independent micro-credentials or as integrated, i.e., stackable towards another larger credential (European Commission, 2022: 27).

As previously mentioned, the standard elements will be included in the European Learning Model v.3 (ELM), which is a multilingual data model for learning that enables interoperability and credential exchange. ELM will provide a single vocabulary for learning in Europe in a field where each country, sector, level, or even institution has its own vocabulary and ways to record data, hindering the creation of common systems and data exchange. With an EU-wide use of the ELM, many of the principles of the Recommendation can be achieved, including, for example, transparency and portability of data, recognition of and trust in digital credentials, and validation of formal, non-formal, and informal learning. (*Launch of the European Learning Model - A New Step for Interoperability in Learning*, n.d.; The Council of the European Union, 2022: 28)

4.3 The principles for designing and issuing micro-credentials

The common definition and the standard elements are the key features of the Recommendation, but it also includes principles for the design and issuance of micro-credentials to highlight the key characteristics of the EU approach to micro-credentials. The 10 principles *"specify the nature of micro-credentials and offer guidance to Member States, public authorities and providers*" (European Commission, 2022: 29). In other words, adopting the principles, i.e., "building blocks," is a vital first step towards a common understanding.

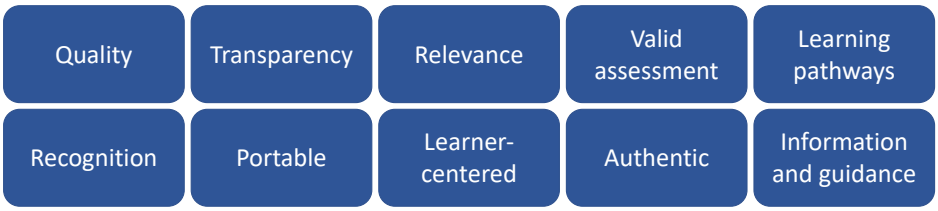

Figure 2. Principles for design and issuance of micro-credentials (European Commission, 2022: 29–34)

The principles are described in detail in the Recommendation (European Commission, 2022: 29–34) and are somewhat overlapping but also complement each other. Many of them are qualitative by nature which means that they are in "the grey zone", i.e., open to interpretation and discussion. Differences in interpreting the principles could lead, in the worst-case scenario, to differences in the implementation as well, watering down the endeavor for common understanding. Next, a short overview of the principles will be provided.

Much emphasis has been placed on ensuring the quality assurance of micro-credentials. The value and recognition of micro-credentials can only be built and maintained if both the internal and external quality assurance processes are clearly documented, involving learners in the QA processes and meeting the needs of learners and stakeholders (read more (Cirlain, 2023).

To enhance the aim of measurable, comparable, and understandable micro-credentials, transparency and clear information are required, especially with the learning outcomes. This applies also to the assessment of the learning outcomes. In any case, micro-credentials should be relevant, which means that they should provide up-to-date, targeted learning opportunities and achievements to meet the identified learning needs.

Stackability or modularity is a way that micro-credentials can be stacked to create larger credentials and even degrees. The principle of learning pathways is, however, more than that. It emphasizes flexibility, i.e., the possibility to validate and recognize micro-credentials from different systems. Especially the validation of non-formal and informal learning is highlighted as part of the learning path. The assessment of learning outcomes is the key, not the way in which the learning is obtained, i.e., a specific course or non-formal and informal learning (The Council of the European Union, 2022: 32).

One of the key questions yet unanswered is the recognition of micro-credentials across the EU. The Recommendation states that micro-credentials are recognized by the competent authorities when the information is *"provided according to the European standard elements and the principles for the design and issuance of micro-credentials"* (European Commission, 2022: 33). In practice, there are still issues to be solved among Member States and individual institutions.

Digital credentialing is an issue when interpreting the principle of portability. Since micro-credentials are owned by the learner and should be easily shared, digital credentialing provides the most convenient solution. The Recommendation calls for open standards and data models to ensure interoperability, easy data exchange, and smooth data authenticity checks. The EC also promotes the use of digital wallets and, for example, Europass for storing and sharing micro-credentials.

The standards and the principles provide a framework for micro-credentials in Europe, but the aim is not to harmonize but rather to build a common lexicon and understanding of (O´Keeffe, 2023). With this said, there is still work to be done to make micro-credentials a valued and recognized way of displaying skills and competences, a trusted currency of micro-credentials. European Universities are considered one of the key initiatives to bring higher education, research, innovation, and society more closely together by introducing a new dimension for European higher education in the form of micro-credentials.

5. Towards a common understanding of Micro-Credentials

The Recommendation, with its three components, 1) definition, 2) standard elements, and 3) principles for design and issuance, is a good first step towards a common understanding and hopefully a trusted competence currency of micro-credentials in the European Union. Still, many kinds of support measures are needed to gain the benefits a European-level mutual understanding and procedures would enable.

The Recommendation includes a description of Commission support, especially in collaboration, technical implementation, and further research (The Council of the European Union, 2022: 23–26).

The EDEH Micro-credentials working group could be considered as one of the examples of the support instruments that enhance the dialogue and collaboration and will hopefully provide some concrete tools to promote the implementation of the Recommendation. One of the aims of the working group has been to involve different stakeholders who provide insights on current challenges concerning micro-credentials from different points of view (European Commission, 2023a, 2023b). The discussions have revealed that the implementation of the Recommendation would not be straightforward, not even in terms of adopting the concept of micro-credentials. The differences between education systems, funding, and legislation, to mention a few, have not been easily surpassed (see also (Cirlain, 2023). The need for a tool or a framework helping education providers and member states assess their own maturity levels was identified and addressed during the work, which continues until the end of November 2023.

Much depends on the Member States and how they address and implement the Recommendation at the national level. The Recommendation leaves a lot of room for interpretation, which can lead to varying national implementation processes. To ensure the best possible common understanding in Europe, collaboration between the Member States is desirable

already when planning the corresponding measures to implement the Recommendation. To achieve an EU-level outlook, a synthesis and an analysis of the measures is necessary.

How the issue of funding is addressed in each Member State is also crucial. If micro-credentials are implemented purely as market-based, industry engagement i.e., industry and HEI working hand in hand, would be a sustainable solution. For individual learners, the price of micro-credentials could become too high without any governmental or other subsidies. That has an impact on the role of HEIs on the fundamental level since industry-relevant and even tailored micro-credential offerings that the industry is willing to pay for require labor-intensive work. To create and strengthen these lifelong learning ecosystems, HEIs are forced to invest time and money. In any case, the need for new business models is apparent.

The Erasmus+ funded European University Alliances are mentioned in the Recommendation as one of the measures that promote the development of the ecosystem for micro-credentials in Europe (The Council of the European Union, 2022: 15). The key question is, how do we ensure that the results of the funding that the alliances have received to promote the cause and tackle the obstacles, especially on interoperability, will be disseminated among all the alliances? Further, is there a risk that each alliance comes up with its own technical and operational solutions that prove to be more exclusive than inclusive? Thus, networking and sharing best practices among the alliances would be beneficial or, one might say, even crucial.

To reach the ideal of a common European competency currency of micro-credentials, it is important for all actors and stakeholders to imagine the bigger picture and to adopt not only the standard elements but especially the building blocks, the principles of design and implementation described in the Recommendation. Trust and recognition are issues that are built over time but lost in a second if compromised. If micro-credential development fails with quality, transparency, or relevance, no common standards will save the day. Also, trust in the transcripts that HEIs provide for their learners is the very foundation of higher education, and every measure should be taken to ensure that micro-credentials will have the same trust and verifiability. This also applies to digital credentialing, where strong verification methods (electronic seal, blockchain technology) would increase trust together with transparency in learning outcomes, assessment criteria, etc. (Kiiskila et al., 2023: 365)

Another risk identified in the working group with the new competence currency of micro-credentials is oversupply, which would lead to inflation of the currency. That risk could be realized if education providers concentrate on quantity over quality or relevance of micro-credentials. The main responsibility of quality assurance and in-demand supply of individual micro-credentials is with the education providers in the internal quality assurance procedures (Cirlain, 2023: 27). Since micro-credentials are not exclusive only to HEIs, it

is also important for HEIs to define their role in the market by providing high-quality, research-based, and future-oriented micro-credentials that provide added value both for the learner and for the industry.

When considering the EHEA and the Recommendation aims of interoperable and coherent European higher education area as well as the current data model and digital service development within the EU, it is evident that digital credentialing is the only reasonable solution for micro-credentials. However, many individual HEIs are still struggling with how to address and solve the issue of digital credentialing, i.e., what technology and repositories to use. In addition, adopting new technology solutions is not just a technological issue but always includes internal processes and competence development. In any case, time and effort are needed, as well as research and experimentation. In some Member States, there are also national-level solutions for digital credentialing ecosystems that take into consideration different sectors and groups of stakeholders and their needs, as well as the tools and technologies available. The approaches and architectures of the ecosystems vary from central repositories, hubs, exchange networks, and badge frameworks to the use of public blockchains (Chakroun & Keevy, 2018: 22–24). Further, the development of Artificial Intelligence solutions might have an effect in the near future.

With all this said, a need for strategic leadership has emerged, i.e., educational leaders identifying and critically weighing up the "*strategic drivers as part of any institutional response*" to micro-credentials in order to, "*critically distinguish between hype and hope*" (Brown et al., 2023: 3)policy-makers and educational leaders are giving to micro-credentials by framing the discussion in several recent high-level policy developments, an exponential growth in the number of academic publications and the increasing level of interest shown by popular media. It follows that micro-credentials appear to be high on the change agenda for many higher education institutions (HEIs. In their recent literature review on micro-credentials Varadarajan et.al. (2023: 12–15) recognized the central position of higher education institutions. They suggest three pathways for HEIs to strategically implement their micro-credential ecosystem:

1. HEIs and learners – Micro-credentials as a learning pathway
2. HEIs and employers – Micro-credentials as an employment pathway
3. HEIs and government – Micro-credentials as a qualification framework

By addressing all three pathways and considering the perspectives of all stakeholders, HEIs can better exploit micro-credentials and build lasting lifelong learning ecosystems. In a functional ecosystem, learning and employment pathways should, however, be implemented side-by-side, described transparently, and communicated openly.

In order to include the preconditions and expectations of all stakeholders in the early-stage adoption of the Recommendation, i.e., moving towards a common understanding, more empirical research is needed. In other words, common understanding requires a triple helix approach (HEI, industry, government), not forgetting the individual learner. The aforementioned three-pathway model for HEIs could provide a fruitful framework for future research. Designing a micro-credentials maturity model, as mentioned earlier in this chapter, could also contribute to empirical research design on institutions' preparedness for implementing micro-credentials.

6. Conclusion

It is easy to talk about micro-credentials as only an education offering or a standard way of documenting learning outcomes. The Recommendation, however, takes a more profound stance on where to focus as a higher education institution. Flexible and short micro-credentials possess qualities that should not be discarded. These call for internal strategies, quality processes, and new business models to unveil the potential and fulfill the expectations of micro-credentials in the most sustainable and profitable way for all stakeholders.

Industry engagement seems to be the key to ensuring workplace relevance and in-demand career skills of micro-credentials. However, micro-credentials should not be dealt with only as industry-relevant education offerings but also as promoting true lifelong learning. By making all learning outcomes visible, they celebrate individual learning efforts and accomplishments outside the formal education offerings. In addition, for individual learners, they are not just a small amount of assessed learning outcomes; they are also the stepstones of a lifelong learning path.

With all this said, the Member States as well as the Higher Education Institutions and European University alliances, have the keys to success in their own hands. The goal of a common understanding of micro-credentials is not reached just by implementing a data model or by competing on the amount of learning offerings provided but with a strategic approach, quality assurance, and active dialogue between all the stakeholders.

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7 THE ROLE OF RDI-DRIVEN EDUCATION IN CREATING SUSTAINABLE DIGITALIZATION AND INNOVATIVE COMPETENCES FOR THE FUTURE

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ABSTRACT

This paper considers various theoretical and practical perspectives of futures-driven digitalized competences within the Research, Development, and Innovation (RDI) practices in the applied educational context. Whereas the paper focuses primarily on higher education, showcases of successful RDI integration between several educational levels are provided. Future's research, aspects of digitalized learning, and viewpoints on connecting RDI and education form the theoretical basis and the article's core. International RDI experts and educators were interviewed within the case study, and multiple observations were conducted. Future's competences for digitalized RDI and sustainable learning were analyzed. The application of multidisciplinary, inter-level online, and onsite RDI interventions was found to positively influence the learning outcomes and thus contribute to a more efficient study process.

Keywords: digitalisation; education; future's competences; future; RDI; sustainability

TIIVISTELMÄ

Tässä artikkelissa tarkastellaan erilaisia teoreettisia ja käytännöllisiä näkökulmia tulevaisuuslähtöiseen digitalisoituun osaamiseen tutkimus-, kehitys- ja innovaatiotoiminnan (TKI) käytännöissä soveltavassa koulutuskontekstissa. Artikkelissa keskitytään ensisijaisesti korkeakoulutukseen, mutta siinä esitellään onnistunutta TKI-integraatiota useiden koulutusasteiden välillä. Tulevaisuuden tutkimus, digitalisoituneen oppimisen näkökulmat sekä näkökulmat TKI:n ja koulutuksen yhdistämiseen muodostavat artikkelin teoreettisen perustan ja ytimen. Tapaustutkimuksessa haastateltiin kansainvälisiä TKI-asiantuntijoita ja kouluttajia sekä tehtiin useita havaintoja. Analysoitiin tulevaisuuden osaamista digitalisoitua TKI-toimintaa ja kestävää oppimista varten. Monialaisten, tasojen välisten verkossa ja paikan päällä toteutettavien TKI-interventioiden havaittiin vaikuttavan myönteisesti oppimistuloksiin ja siten tehostavan opiskeluprosessia.

Avainsanat: digitalisaatio; koulutus; tulevaisuuden osaaminen; tulevaisuus; TKI; kestävyys

1. Introduction

Digitalization is widely presented in all stages of the educational process. Moreover, modern generations are becoming more digitalized than before. In contrast to their teachers utilizing online solutions in their everyday teaching practices, students live in an entirely online realm. As such, digitalization has become one of the basic needs of students (Jakoet-Salie & Ramalobe, 2023). The online and offline principles of everyday life and education are becoming blurred and hardly distinctive from one another. Access to information and the globalization tendencies of education within the European Union have increased the digital research literacy of students who receive better opportunities to engage in international student mobility and participate in educational RDI projects (Mannelli, 2023). As such, internships and theses of bachelor's students include RDI elements, whereas studies of master's students are fully based on RDI competences in the applied university context.

In order to elaborate on sustainable digitalization and innovative future-driven learning, this paper analyses future competencies required for sustainable learning and RDI professional development in our digitalized world. As one of the central outcomes of the previous educational, international multidisciplinary project Race4Scale, the following nine competences were elaborated on and further applied in this paper: creativity and innovation, intercultural communication and connectivity, cross-disciplinary critical thinking, customer intelligence,

global citizenship, project work and team leadership, digital literacy, sustainable growth and social development, and future's mindset (Nemilentsev 2022). In addition, various learning strategies through RDI are applied to more classic educational processes to form the future playground of RDI-based education (Hensley et al. 2021). Learning by playing, learning by experiencing, and learning by feeling provide multiple benefits to the established teaching practices and increase sustainability in learning by better engaging with the fully digitalized student generation (Nemilentsev, 2023b).

As an RDI expert of the ESR+ project "Work life path – international experts to work," the author has an opportunity to study the opinions of international students, educational and industry experts, as well as RDI representatives of several directions (e.g., Digital Economy, Creative Industries) within South-Eastern Finland University of Applied Sciences - XAMK as well as within multiple international RDI networks.

This paper uses a case study approach to analyze the future skills and competences and the continuous influence of digitalization and digital transformation delineated partly in the previous international project Race4Scale (Nemilentsev 2022; Priya 2021). The case study mainly used theme interviews to collect the empirical material. Thematic interviews were conducted with two Finnish project managers from Xamk, two German, six Bulgarian, one Nigerian, and one Bangladesh RDI expert. They were supplemented by the author's reflections based on the Innovation Frontiers and Sustainability conference – in Burgas (Innovation Frontiers 2023). Despite the small sample size, the interviews yielded rich research data that might be useful for other research and educational organizations. The interviews were freeform and conducted in a discussion-style conversation with experts in future's research (Elhami & Khoshnevisan 2022). The topics of the interviews included aspects of a digital mindset, future-driven RDI skills, RDI team composition, and values. In addition, the reflections of the international multidisciplinary project Race4Scale team were applied where the author performed several innovation project activities on future´s research and innovation (Race4Scale 2022). This article proceeds as follows. Applied theoretical considerations of digitalized education and applied research-based learning are complemented by the discussion of the empirical interview and observation results in the case of the ESR+ project. Subsequently, future competences for digitalized RDI and sustainable learning are analyzed.

2. Connecting RDI and Education

Education generates the foundations of a student's research mindset. There can be a discussion about the goals of connecting RDI and education within the digitalized life setting (Morsello, 2023). Research is inherent in scientific schools, researchers, and businesses. However, simply studying the practical (applied) spectrum of social and business phenomena development as part of education does not provide the opportunity to implement a project with sustainable value successfully. Therefore, the beauty of the applied approach in education lies in using the results of direct academic and practical research to the realities of modern society and testing key findings. The combination of research and development activities leads to the long-awaited disruptive leaps from one trajectory to another - namely, the innovation phase begins.

The process of flowing through the research, development, and innovation phases is long, with many qualitative and quantitative iterations. Since innovation cycles have sharply shortened in recent decades due to the global digitalization of work processes, the growth of the global population, and the rise of the knowledge-based innovation economy, such cycles of iteration (research-development-innovation) are optimal for applied study within a curriculum (Ciriello et al. 2018). However, at what stage of education (preschool - school - vocational secondary – tertiary education) should RDI activities be included?

More daring digitalized user-driven projects are often carried out in schools and preschool educational institutions. Children are entrusted with large-scale interventions to protect the environment, improve happiness and safety, and conduct physical and chemical experiments presented in a playful way (Kupiainen 2022). At the same time, realizing such project ideas often occurs in a hybrid or fully online form. It is precisely a certain childlike form of curiosity, openness, and desire to change the world for the better that adult projects usually lack. Along with the recent school phenomenon-based learning initiative, it would also be interesting to solve 360-degree experiments to create multifaceted experiences and expand abductive thinking among young and adult generations of students in the applied university context (School Development Program 2023).

Hackathons or innovative challenges, which usually last 12, 24, 48, or 72 hours, provide complete immersion in the problem of the case. These are often successful and, at the same time, understandable forms of project implementation. At the same time, during the event, there is an ideological rapprochement between the participants, where the age, experience, and professional status of team members are replaced by effective collaboration (Ringby & Duus 2017). For the same reason, successful projects in terms of the depth of the solutions built could, for example, be an international project where students at a high school

science center research and practically develop digital technical processes along with Doctoral, Bachelor, or Master students from the leading scientific centers of the participating countries. Digitalization and digital transformation will be learned between generational and educational levels. Further, the developed innovative concepts would be continuously simplified throughout this method. Thus, scientific methods and the development of ideas, in general, become understandable to ordinary consumers to address the growing anti-expert trend in society.

To achieve sustainability in applied scientific activity, it is necessary to have simultaneous involvement in the development process on the part of the management of educational institutions, the business sector represented by cluster organizations, and directly from trainers or teachers teaching students. Following the current needs of the digital native generation in continuous limitless learning, traditional offline onsite collaboration should be more intensively transformed into a fully digital format with evolving digital competences of educators and managers.

By way of analogy, it is difficult to teach reading when you are not literate. Sometimes, it seems that the modern generation can learn a profession on its own and gain a higher education without the help of teachers. After all, we as teachers often think with a significant time and competence lag. In other words, while we take advantage of innovative developments through digital training and other on-the-job courses, the younger generation of students is already, as if by instinct, living in digital realities (Grous 2022). This is perhaps one reason why many students who began their studies during the pandemic do not see any value or reasonable sense in returning to the walls of schools and universities post-pandemic.

For example, digital transformation occurs when monitoring the cultivation of grapes in the city of Plovdiv, in the entertainment sector when monitoring the safety of visitors to the water parks of Nessebar and Sozopol, in industrial and technical education in the Bavaria region (Bavarian Foresight Institute 2023). At the same time, digital solutions reflect social changes and are an example of the ongoing digital transformation of society.

As a main theoretical conclusion, it can be assumed that an effective model of applied future-oriented digitalized learning should include hybrid forms of work, 360-degree immersion in the phenomenon of the problem, and limitless group interaction of students, teachers, and other stakeholders of the educational process.

3. Interview reflections

Interviews were conducted with project experts focusing on innovations, future research, and team management. The interviews were thematic, including several themes and free discussions with two Finnish project managers from Xamk, two German, six Bulgarian, one Nigerian, and one Bangladesh RDI expert. The German experts work on innovation impact and future foresight in the Bavaria region. In contrast, Bulgarian members represent Sofia, Plovdiv, and Burgas regions, working at the intersection of agriculture engineering, blockchain, ICT, innovation, and entertainment business. In addition, the data was supplemented by observations from the author's ongoing and completed projects and communication with the project partners and research staff.

3.1 Digitalization and learning mindset in RDI practices: towards data-driven networking mindset and agile solutions

The boundaries of real offline and online life are becoming more blurred: friends, services, and information are almost completely reflected in the online realm. Morden day work is becoming almost completely online, too, with personal face-to-face meetings becoming rare. For this reason, newly designed education degrees and RDI projects imply the priority of digital standards. On the one hand, savings can be found from a reduced physical presence and fewer onsite activities within international or regional projects. On the other hand, the value of live communication and the effectiveness of working shoulder-to-shoulder are lost. In addition, longstanding teaching conventions are being eroded. In line with competence-based education in Finland, students are provided with an individual approach without reference to specific dates or class times. Again, the younger generation absorbs information much faster, and people learn most effectively from examples - their fellow students (Kupiainen 2022). It is expected that project and teaching staff should become role models and act as facilitators online and offline for each student individually rather than for the whole group.

It can be noted that in the classical sense, students involuntarily become lazy during long lectures or workshops as if deliberately underestimating their activity in the discussion process or simply "disappearing" from their gadgets (Khoza 2022). On the other hand, their working potential is much higher during periods of active work in comparison with senior representatives of project activities. Instead of long-term, equally good group project work, youth demonstrate character through creative insights and experience sharing. Thus, I would like to posit: is it necessary to leave classical full-time education with prevailing contact

classes at applied universities? Would it perhaps be more beneficial to build the entire RDI learning process as a nesting doll of development projects with mixed long-term processes of interaction between stakeholders and a hybrid contact structure of communication with the simultaneous presence of online instruction and online reporting forms about the work done and onsite events. To implement such a model, facilitators are needed as cultural and intergenerational ambassadors of digital project changes in the person of students - that is, the younger generation, and not vice versa, as we are more accustomed to seeing. It is not the students who need interpretation and consultation but the senior project and teaching staff.

From the point of view of building an effective contact network, in modern digital realities, the importance of younger influencers in social networks and communication channels can overshadow the authority of older experts. What is social or human capital in modern realities. Given the current emergence of Industry 4.0 and the impact of digital artificial intelligence, networking should already include digital data capital, not just interpersonal communication. Networks for RDI projects are built, emphasizing access to digital data and data analytics. Project results become more agile, and iterations of lean development characterize innovations.

3.2 On the efficient RDI project activities and relevant RDI values

Clarity of project boundaries, clear structure, and accessibility of presentation of information distinguish effective RDI activities. Transparency of the structure is required to ensure that all stakeholders use the same rules of the game to complete project tasks. In addition, with a hybrid team structure and the interactive nature of project work, each member should be allocated their range of tasks and the scale of the data being processed. The relationship between ongoing projects and a certain continuity of the results of already completed collaborations increases the value of project interventions. It leads to greater disruption of the phenomena being studied. As important skills and values are being formed, we can highlight networking as the ability to establish new forms and areas of communication, as well as curiosity, with its inherent search for new areas of coverage and target groups. Stress management and a sustainable constructive approach to criticism of non-trivial project decisions increase the survivability of project results.

RDI activities should bring their own unique contribution and new perspectives and have a clear commission. Intellectual property rights and an RDI impact are controlled success factors. In general, research impact relates to societal values and regional scope. As such, RDI projects should function as regional RDI hubs to bring continuous renewal and positive changes.

3.3 innovation for future-driven RDI activities and team attributes

The usefulness of action is the key to the success of the project. Each stage of planning, implementation, and audit should have impact and sub-efficiency metrics, preferably of a qualitative nature. Creative industries even require a certain amount of disorder - the ability to completely abandon standard solutions to a problem and focus on innovations that are not yet possible. Thus, based on such precedents, it is possible to gather the necessary public opinion and compare it with the RDI ideology of the project team.

The heterogeneity of a team plays a leading role in the start-up setting. Therefore, team structuring can be separated as an RDI subproject. Multiple viewpoints stem from the RDI team's diversity and openness to the ideation processes. Future research itself can be characterized by sustainability, digitalization, predictability, and sufficiency. It provides a continuous evolution of the creative mindset required for productive future-driven work processes.

4. Future's competences for digitalized RDI and sustainable learning

As the result of the conducted international project and as a part of the action research, the role of digital transformation on learning and growth of the future's mindset is analyzed through the development of interrelated future-driven competences that will be of high demand for future generations (Race4Scale 2022). All in all, multiple project meetings, online innovation camps, and future workshops were organized with educators, business representatives, and students from universities, universities of applied sciences, colleges, and gymnasiums to verify the future's mindset and influence of digital transformation. These interventions took place during 18 months in the Race4Scale project. After the project's completion, meetings on sustainable learning with the Kymenlaakso business and municipal leaders were organized between XAMK and LUT universities (Nemilentsev 2023a).

As one of the major outcomes of the recently completed international RDI project, the author developed nine integral competences that form the future digital project mindset that can be expressed by interconnection (Nemiletsev 2022). These competencies are based partly on transversal skills.

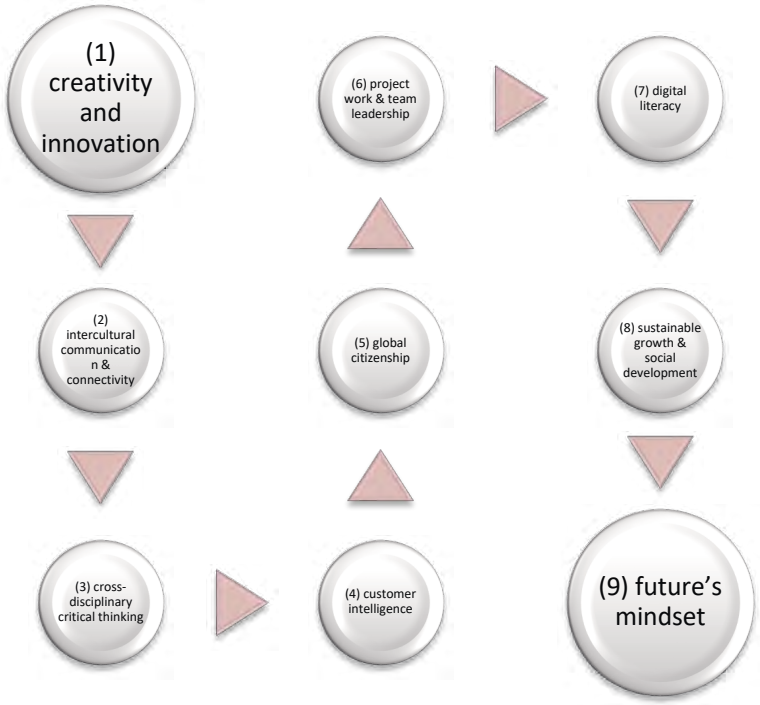

Figure 1. Future's competences – towards a future's digitalised mindset (adapted from Nemilentsev 2022).

(1) Creativity & innovation

The digital skills of the younger generations are significantly better than those of the older generations. The modern young student is characterized by the speed of searching for new open material, the ability to handle technically complex systems of augmented or virtual reality, and the constant "digital inclusion" of all possible and impossible gadgets. However, the quality of the information obtained, the ability to think outside the box, and the ability to create value from the information received leaves much to be desired. An earlier study from an international project developed a set of competencies that could help in the future, focusing on digital and social development (Arola 2022, Nemilentsev 2022).

(2) intercultural communication & connectivity

Intercultural communications and the ability to connect people and information are of strategic value in an increasingly digital world. In addition, the constant "hybrid modality" of life blurs the criteria for interaction online or offline. It is almost impossible to satisfy online requests without the personal participation of business representatives. At the same time, traditional forms of studying or working on campus or in the office include meeting with colleagues in Teams or Zoom.

(3) cross-disciplinary critical thinking

The digital realities of society push us to look for matrix ways of interdisciplinary interaction. Companies may be decreasing their number of employees due to robotization and outsourcing. But at the same time, completing tasks for a small project, both in school and at work, requires the involvement of often unrelated professionals. Society's intellectuals are growing both in volume and in quality.

(4) customer intelligence

Entire production processes can occur online. As life profiles change, consumer preferences change. The concepts of impact and value are acquiring digital characteristics, and considering the interaction of representatives of the modern "borderless" generation, consumer behavior is also moving into a hybrid form. This increases the importance of digitalization in purchasing decisions and the general consumer market situation.

(5) global citizenship

The development of digital technologies is changing how project employees and partners view the arena of action: from local and regional projects, they are being transformed into global startup ecosystems. In general, of the three main development paths, collaborative born-global paths appear to be the most organically integrated into digital market solutions.

(6) project work & team leadership

Individual work with a standard list of required tasks fades into the background. Currently, managers and subordinates are acquiring more and more team qualities. Growing enterprises place strategic, sustainable improvement in their organizational culture and flexible, positive leadership in their organizational structure - hybrid in nature, incorporating digital and offline components.

(7) digital literacy

Simply using a PC is insufficient to perform business functions in an enterprise. The so-called limitless digital generation (also known as the Millenials or Z generations) demands effective analytics of digital data and the confident use of programming languages (Dimock 2019). Essentially, they act as digital architects of design work at their enterprises. Therefore, the inclusion of advanced processing of open and big data, as well as the development of elements of augmented, virtual, and mixed (X) reality, should be used when forming the mindset of this generation - that is, forming their digital literacy.

(8) Sustainable growth and social development

Any technological or economic task includes a set of measures to ensure sustainable growth of the enterprise, all stakeholders together, as well as key societal and social processes. This

is clearly seen in international project activities, where the digital future looks balanced from social and human perspectives and is also based on the principles of sustainable development (UNDP 2023).

(9) future's mindset
If the current young generation is already limitlessly digital, what does the future see: a complete deformation and immersion of the boundaries of the real, augmented and digital. The emphasis is on the innovative potential of the future generation and its creative value. Digitalization is already the present but also a significant part of the future that is currently being formed.

5. Conclusion

The structure of higher educational processes should be better adapted to modern projects and work activities in the digital realm. Interviews and empirical observation revealed that using short posts along with scientific or practical articles, headlines, and minimal explanations with plenty of online links is a more effective teaching method than full traditional lectures (Sivakumar et al., 2023). The online format of courses or project manuals on interactive platforms does not solve the problem of perception, crowding, and engagement with the material. Without properly instilled motivation, learning becomes another routine to obtain a grade and the required study credits (Herodotou 2019).

According to the paper results, the learning process itself could be reorganized as a sequence of continuous RDI experiments. For example, it can be implemented as a part of a multi-year regional or international project, where the target group - the students being taught - also bear equal responsibility for the assimilation of knowledge, the speed, and quality of passing intermediate checkpoints by analogy with the preparation of quarterly, semi-annual, and annual reports for the needs of funding organizations. What if the low-impact role of the teacher in the modern sense was replaced and all employees were made mentors and facilitators without the need to keep quantitative records of student performance and completely focused on qualitative competences. Of course, this will require considerable financial costs and, most importantly, time. This would help to increase the responsibility of the younger generation and form the so-called rules of the game within the framework of existing projects (Kärki et al. 2021). There is no need to be afraid of unsuccessful experiments because, with the help of hands-on experiments, precedents, and development cases are first created and then interpreted. It has the characteristics of induction and abduction, but most importantly, action and proactivity take precedence over a clearly planned process. In essence, this is responsible for co-creation with a lean iteration methodology and

non-discriminatory logic of lateral interaction. For example, De Bono's Six Hats method is a clear example of this (Channell 2021).

In cross-country comparisons, Finnish culture belongs to cultures where the value of life prevails over work in the work-life balance (Eskelinen, 2023). Instead of results, well-being and happiness in life are valued and prioritized. That is, for successful innovative project activities, the development process should be turned into a hobby - something where there is sincere curiosity, personal interest, and the primary intangible but rather emotional and aesthetic interest of the participants. There must be "childishness", play, movement, and mystery within such a design experiment. Moreover, digitalization already lives in the young, although information literacy skills require continuous tuning (Dimock, 2019). It is passed on to adult generations following the example of numerous episodes of the Black Mirror series (Sorolla-Romero 2020). The prototype of the reality of the matrix perception of the working world of human interactions and digital information depends on us and our changing mindset.

This paper analyzed the development of sustainable competences for the digitalized future from both theoretical and practical viewpoints. Recent studies on connecting RDI and learning were considered in the applied educational setting. Practical considerations of digitalization and digital transformation were considered from multiple educational perspectives. The case study approach was used with the combination of theme interviews and observation of the author from several international conferences and RDI project activities. Future's competences for the digitalized life and study setting were discussed in a detailed way. The use of intergenerational, multidisciplinary, hybrid (online and onsite) RDI interventions was proven to positively affect the learning outcomes. Theoretical and applied analysis strengthened the empirical findings.

As a possible direction for future research, the impact of applied hands-on education on students' employability and the formation of a new branch of project-intensive specialties can be studied. In addition, students' entrepreneurial competencies regarding their digitalized learning habits should be examined in more detail. In this way, it will be possible to understand the reaction of the labor market to the formation of new-level specialists who have received applied futures-driven RDI education and possess efficient digitalized learning competences.

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8 CONCLUDING REMARKS

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1. Digitalization and Professional Research Writing

In this issue of Xamk Beyond, our authors have explored several important topics under the broad topic of "Digitalization." We have had insightful contributions on topics ranging from using games in business education to the potential of Open Source Software for small and medium-sized institutions and the growth of micro credentials in education. With these articles, our authors are contributing to the digitalization literature and deepening our knowledge of practical implementation strategies in the spirit of universities of applied sciences. However, there is one artificial intelligence tool that is absent from this issue of Xamk Beyond: Chat Generative Pre-trained Transformer or ChatGPT.

The development of Large Language Models (LLM) and Generative Artificial Intelligence (GAI) are transforming the landscape of scientific writing and research. Their adoption into general usage earlier this year has shaped societal and academic discussions worldwide. Around coffee tables, on social media, and in the academic literature, there have been many discussions about their impact on science, society, and education, ranging from enthusiasm to fear to condemnation and praise. Some writers have gone so far as to name ChatGPT a co-author on their scientific papers, while others have called this an affront to the dignity of science (for further reading, see Scimeca & Bonfiglio, 2023). Within this polarising debate, higher education institutions have been scrambling to comprehend what these new digital tools mean for education, student learning, and assessment (Firat, 2023). However, there has been insufficient time to assess the impact of these LLM and GAI tools on higher education and society properly. Science, after all, takes time.

Even if were possible, putting these LLM and GAI tools back in the proverbial box is not a constructive approach, and prohibiting their use in writing and publishing is unrealistic. Therefore, what should we do to rise above the mediocre baseline of artificially generated text, as Rehn (2023) suggested, and use them responsibly according to good practices of open science and research? Perhaps this is a somewhat leading question, but it encapsulates

our understanding of the general spirit of debate on GAI and LLM. The rhetoric of these discussions somewhat mirrors the concerns about a "credibility crisis" of science, in which one, to paraphrase Freese et al. (2022), orders a sausage in a restaurant and is unable to see how the process of how the sausage is made, prepared, and served to the hungry customer. Much like an author's use of ChatGPT in research writing. How, why, and to what extent LLM and GAI were used in research and publications are often left unsaid.

We suggest that we return to the fundamentals of responsible science to find pragmatic, constructive ground for using LLM and Generative AI in research writing and publishing. Responsible science should be transparent, reproducible, and open (Tijdink et al., 2021). Therefore, the use of LLM and Generative AI in research and publishing should also be transparent, reproducible, and open.

2. The Ethical Use of AI Tools: Transparent, Open, and Reproducible

Transparency is crucial to responsible science. Therefore, when using Generative AI or LLM, one should always disclose its usage in the research process or outputs, such as assisting with the writing of a research article.[5] It may not always be apparent to the reader if, for example, ChatGPT was used to generate text for parts of a research article. A recent study investigating the ability of reviewers from several top linguistic academic journals to detect artificially generated text found a 38.9 % positive identification rate of abstracts written by Generative AI or LLM (Casal & Kessler, 2023). This figure is worryingly low if we consider the claim that AI-generated text is the mediocre baseline. However, the authors focused on abstracts, which are usually formulaic, follow a known pattern or structure, and are short in length. It is quite well-documented that GAI or LLM start to hallucinate, i.e., invent text, when drafting longer works (Cassal & Kessler, 2023).

In a large-scale comparison of essays written by high school students and ChatGPT, Herbold et al. (2023) found that AI-models produce significantly higher-quality argumentation and use more complex language than essays written by humans. However, there are some methodological caveats here: the essays were very short, around 200 words in length, and the high school students were posting their work in an online essay forum seeking feedback from others. This likely indicates their work or, indeed, their thinking is not yet complete.

[5] ChatGPT or similar were not used in the drafting of this conclusion.

Being transparent with the use of digital tools is responsible science, similar to citing references, and maintains good ethical and methodological research standards. When we chat with ChatGPT, we might think it is generating text based on our inputs and specified parameters. Thus contributing to the belief that we are the active commissioner of the data and that it is our tool or research assistant. There is some truth to this as AI tools are built on deep learning algorithms which fetch data from its, often-undisclosed, sources and generate text based on your query (Elsevier, n.d.). However, these algorithms can and do make mistakes. Like all sources, these can be prone to biases and could even perpetuate inequalities and stereotypes, particularly with gender and race (Gross, 2023). Further, the original data might itself be biased, and therefore, the resulting interpretation of it would also be flawed (see Ferrara, 2023).

Acknowledging these potential biases is a good methodological practice. These same considerations are important to remember when using any digital tool. For example, articles on Google Scholar are not listed impartially; citation metrics play a part in ranking the retrieved sources. Citations, after all, are not an unbiased measure of the quality of an article. In a survey of articles published in International Relations journals, Maliniak et al. (2013) found that articles written by men receive significantly more citations than articles written by women. They attribute this to citation networks and the tendency of men to cite themselves more than women (to read more about gender bias in citation and research, see Ahmed, 2017). As a result, articles with male authors will appear more frequently in Google Scholar than articles written by women. This raises several ethical questions when using AI-generated text. The generated text is based on work written by others and combined from different sources without credit to the original author. The same can be said for generating images, but the discussion of artistic integrity is beyond the scope of our reflections.

In some circumstances, material generated by LLM and GAI is plagiarised (see Gaggiolli, 2023). As the algorithm fetches the data from the original sources and reconstitutes it to answer your query, there is a danger that it does not paraphrase or even acknowledge the sources for you to cite or verify. Furthermore, depending on the version of LLM or Generative AI, the sources may already be quite outdated, with newer, accurate sources locked behind a paywall (Nield, 2023). If a section of work is identified as plagiarised but was, in fact, Generative AI text and this is not disclosed, it could be disastrous for a researcher's reputation. Thus, in the absence of being able to verify the sources, being transparent about how and where data or literature was gathered, reviewed, or analysed is an excellent second choice. After all, responsible citations and acknowledgements are key cornerstones of open science.

In a similar methodological vein, responsible science should be reproducible (for a more detailed look into reproducible science, see Munafo et al., 2017). For our purposes, however,

we use a simpler understanding of reproducibility using LLM and Generative AI. If these tools are used to generate or analyse data, then the exact prompts used should be discussed within the methods section of a paper to enable others to retrace the steps and reproduce the work. The chat transcripts should be saved and made available upon reasonable request. This can shield the writer or researcher should accusations of plagiarism or poor methodological or ethical choices be levied against them, as they can produce evidence of how the work was conducted. Further, this enables others to replicate or reproduce the work, validating or refuting the claims. This practice would be especially relevant for students writing master's theses or doctoral dissertations when they are still being trained in research practices and scientific writing.

It could be argued that the use of generative AI threatens science's integrity and transparency, as there is a lack of openness with these digital tools in how they work and where they get their information. On the other hand, openness is an issue for research and publishing in general. Too much publicly-funded research is published locked behind journal paywalls. Responsible science is open science. Publishing our work, including our data, methods, and articles, openly (when ethically possible) contributes to the general body of material available for research. Thus, if you are constructing your own LLM, tailoring a model, or adapting generative AI, consider making your code open and accessible.

Not all tools are created equally, and there are open source models which may align better with your research values than closed source models run for profit (Davis, 2023). This raises another important consideration: sharing data with private companies gives them access and the right to your work unless specifically stated otherwise. Assume any information typed into services like ChatGPT is absorbed into the service to be used by others. Do not share private, sensitive, or otherwise privileged information with services, especially with empirical interview material or data that might cause harm to the participants if publicly revealed. As of April 2023, around 11% of data stored in ChatGPT is sensitive information that employees have copied into the system (Klinger, 2023).

In sum, it is a good practice for writers to be transparent about how, when, and why they use LLM and Generative AI. Perhaps this could become standard practice in methodology and data sections in papers or placed with ethical considerations. The version of the digital tool used (such as ChatGPT v4) should also be mentioned. Any chat transcripts should be saved and made available upon request. Much like the use of a calculator, it's important to be able to show how you arrived at your answers. Using text generated without any references or adaptation into publications is a poor research practice. Sources should always be cited, lest the author find themselves accidentally guilty of plagiarism. Assume any data shared with the digital tool will be made publicly available to others and acknowledge that the data

you get from these tools is potentially biased in some way that might not be immediately apparent. Finally, as always, remember to consider copyrights and good research ethics.

These concluding remarks on the use of LLM and GAI in research, writing and publishing in Universities of Applied Sciences are by no means exhaustive or comprehensive. We wanted to reflect and suggest a constructive rethinking of their usage through the core tenants of responsible science. There is still much work to be done here, but these good practices are a start for professional research publishing.

3. Toward Professional Research Writing

In previous conclusions of Xamk Beyond, we have taken the time and space to reflect upon the development of professional research writing and publishing in Universities of Applied Sciences, and this year is no different. In 2021, we opened the discussion on the budding scientific and research writing tradition at Xamk – we explored how we could link the United Nation's Sustainable Development Goals to supporting the growth of a constructive and healthy writing and feedback culture grounded in the principle of 'slow publishing' (Neuvonen-Rauhala et al., 2021). Indeed, we did just that and created the scientific writing career path to allocate resources to those wishing to develop their scientific writing and publishing competence (see Weaver, 2023). In 2022, we explored the impact of our activities as editors of Xamk Beyond. We concluded that while the writing and feedback processes of Xamk Beyond are heavier than our other publication series, somewhat mirroring that of a traditional scientific journal, it provides a constructive forum for staff to develop their research writing skills in English and receive constructive feedback (Neuvonen-Rauhala & Weaver, 2022). In this issue, we have taken the time to reflect on using digital tools in professional research writing.

Unlike other types of publications, such as scientific articles, chapters in edited volumes, and even publications intended for the general public, a professional article or publication varies significantly in scope, breadth, and style. Even within our own publication series at Xamk, most publications in Beyond & Research, Develop, and Inspire, fall under the broad classification of professional publications or D-Type according to the Ministry of Education and Culture's classification system (Kansallinen julkaisumetriikkaopas, 2023). However, the diversity of what constitutes a professional article, how they are evaluated and assessed, and even laid out is significant. Just this year, mapping work was started by a national working group to understand the measure of a professional publication; attempts are also being made to define a common set of guidelines for this varied classification.

While we understand Xamk Beyond as having somewhat stricter feedback processes for this classification, we also see it as a method of developing our evaluation culture. It would be easy to mistake our interventions as a desire to elevate Xamk Beyond from a professional publication to a non-refereed scientific journal, but doing so would impose even more limitations on our writers and potentially reduce the freedom we have as editors of a professional publication.

Xamk Beyond has been both a mechanism to develop and elevate the research writing competences of our staff and act as a forum for producing quality professional publications in English to further increase the impact of our work at the South-Eastern University of Applied Sciences. While the number of writers in this annual edition is lower than we expected, the response to the call for papers for the first Special Issue of Xamk Beyond on 'Futures,' which will be published early in the new year, has been encouraging.

We value the diversity of our writers, who come not only from RDI units but also from Education departments and the Administration and Support Services. Research writing is not always grounded in actual research but is the style and convention applied to a publication type. You can write great research papers without having done "research" in the traditional sense of the term. So, if you have no ideas about what you could publish, consider your work and the material that interests you, and reflect on what makes it interesting. From this, you might be able to write an engaging publication that people want to read.

We want to thank our authors for their hard work in continuing to publish their education and research activities in English.

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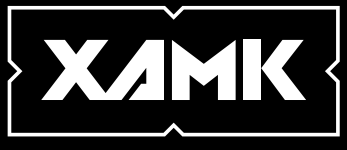

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