The development of ERP-related courses for purchasing and logistics students

Case: ERP and Logistics Simulation courses at JAMK

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Description

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Abstract

The high demands of industry necessitate continual improvement in university curricula. Enterprise Resource Planning (ERP) systems, especially SAP S/4HANA, have become omnipresent across organizations regardless of size. Recognizing this growing importance, Jyväskylä University of Applied Sciences (JAMK) has for years incorporated ERP and Logistic Simulation courses into the curriculum for logistics and purchasing engineering students. However, ensuring these courses remain relevant to students' professional development requires ongoing evaluation and adaptation.

This thesis addresses the critical need to narrow the knowledge gap between students and the updated requirements of the SAP S/4HANA system. By employing a mixed-methods research approach, the study gathered data from both students and industry professionals. A survey containing both quantitative and qualitative questions assessed 33 students' current knowledge base regarding ERP systems. Additionally, in-depth interviews with 2 students provided richer insights into their learning experiences. Finally, 2 expert interviews with 4 industry professionals explored the specific skills and knowledge employers seek in graduates.

The research findings clarify key areas for improvement within the ERP and Logistic Simulation courses at JAMK. These areas include the course schedule, teaching methodologies, the learning environment, instructional materials, the use of case studies, assignments and the integration of different courses. While implementing the proposed solutions may require significant adjustments, this thesis offers a comprehensive framework to bridge the knowledge gap and ensure JAMK graduates possess the necessary skills and expertise to thrive in the modern dynamic field of logistics and purchasing engineering.

Keywords/tags (subjects)

Enterprise Resource Planning Course, ERP, Logistics Simulation Course, SAP S/4HANA

Miscellaneous (Confidential information)

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1 Introduction

The background information, goals, research questions, scopes, and constraints of the thesis are presented in the introduction chapter. The goal of the introduction is to make the subjects and substance of the thesis clearer.

1.1 Background and Objective

Enterprise Resource Planning (ERP) is a software program that helps in managing and automating core business processes for organizations to operate at their optimal level. According to Vogel and Kimbell (2005), SAP essentially presided over the ERP system's birth. Organizations can centralize data management of their key business activities, including procurement, production, materials management, sales, marketing, finance, and human resources, with the use of SAP ERP. The system plays an important role in modern businesses, particularly in the purchasing and logistics domains. SAP (2024) reported in its corporate fact sheet that 99 out of the top 100 global corporations are SAP clients. Therefore, there is a growing demand for purchasing and logistics professionals with comprehensive knowledge and skills in SAP ERP systems. In today's competitive job market, students need to gain hands-on experience with SAP ERP early on in their academic journey. The continuous development of SAP ERP systems leads to the request to continue developing and updating the training program for purchasing and logistics students. This thesis aims to narrow the knowledge gap between purchasing and logistics students and SAP ERP systems by developing recommendations for improving JAMK's current ERP-related courses which are ERP and Logistics Simulation.

The ERP course equips students with an overview of ERP systems, their role in strategic and operational management, and their successful implementation in real-world business environments. Furthermore, students can gain a comprehensive understanding of ERP technology, data management strategies, and business process integration by analyzing real-world ERP case studies and gaining insights into practices and challenges via the SAP environment. On the other hand, the Logistics Simulation course provides a deeper understanding of business strategy, processes, and decision-making. By collaborating with others in simulated business environments and leveraging the SAP environment, specifically in SAP S/4 HANA, students can enhance teamwork and collaborative skills to enrich their simulation experience and apply the concepts they have learned in a real-world context.

The objective of the thesis is to close the knowledge gap between students studying purchasing and logistics and SAP systems. This will be accomplished through a thorough examination of their existing knowledge and skill levels. Building upon these insights, the thesis will evaluate the necessity for the improvement of ERP-related courses at Jyväskylä University of Applied Sciences (JAMK) and propose strategies for their continuous development. The ultimate goal is to guarantee that these courses continue to be relevant to students' professional growth and align with the evolving industry demands.

1.2 Research Questions and Research Methods

The right question can glow a revelation. The transition from a thesis topic to research questions is an important step in becoming more research-minded since it initiates the line of reasoning that will allow come up with coherent conclusions at the end (Davies, 2007). The thesis topic is the development of ERP-related courses in the purchasing and logistics engineering curriculum. The research questions (RQ) includes:

RQ1: Why is the SAP ERP system important for purchasing and logistics engineering students to learn?

RQ2: What is the gap between students' knowledge of SAP ERP systems and the industry's requirements?

RQ3: How can ERP and Logistics Simulation courses for purchasing and logistics engineering students, focusing on SAP systems, be continuously developed, updated, and improved to ensure students possess the necessary knowledge and skills required by the industry?

The literature review explores RQ1 by delving deeper into the SAP ERP system and its industry significance. This analysis underscores the necessity for purchasing and logistics engineers to possess expertise in this essential system.

Building upon the insights gained from RQ1, RQ2 will investigate the current gap between the knowledge acquired by students in ERP-related courses and the specific skill sets demanded by the purchasing and logistics industry. To investigate RQ2, this research employs both quantitative and qualitative methods. A survey is sent to the target group who have taken the ERP and/or Logistics Simulation courses to gather quantitative data (statistics) on student knowledge of SAP ERP systems.

On the other hand, interviews with students and industry experts are conducted to collect qualitative data (in-depth insights) about the specific skills and knowledge students lack compared to industry expectations.

Informed by the findings in RQ1 and the identified knowledge gap in RQ2, RQ3 will explore strategies for the continuous development, improvement, and update of ERP-related courses for purchasing and logistics engineering students. The focus will be on SAP systems, aiming to equip students with the vital knowledge and skills demanded by the industry.

1.3 Scopes and Constraints

ERP systems play a critical role in modern supply chains, particularly for professionals in purchasing and logistics. ERP and Logistics Simulation courses have been providing students with SAP S/4 HANA experience via case studies and simulation games. By clearly defining the scope, this research will delve into the concepts of SAP S/4HANA, a cutting-edge version of the SAP ERP system known for its advanced capabilities. With its emphasis on in-memory computing and enhanced features, SAP S/4HANA represents the leading edge of ERP technology. This is consistent with the data provided by SAP in 2022, there are more than 19,300 SAP S/4HANA customers and at the end of 2023, the SAP S/4HANA Cloud revenue increased 67% to €3.49 billion. Focusing on this specific version ensures the research addresses the most relevant skill sets sought after by employers – SAP users. Since this thesis specifically targets purchasing and logistics engineering students at JAMK, by equipping them with the latest SAP S/4HANA knowledge, they can be outstanding candidates in the industry job market.

Similar to all research, this study has some constraints. The sample size of the student surveys and interviews (33 and 2, respectively) may limit the generalizability of the findings to the entire student population. Additionally, the courses were implemented based on industry requirements identified through internal development, and the initial plan and underlying research were not formally documented. The perspectives of a limited number of industry experts (4) may not fully capture the entire spectrum of modern industry expectations. Finally, the proposed improvements require implementation and evaluation to assess their effectiveness. As a result, the broad applicability of this thesis can be definitively proven after a comprehensive plan and changes are implemented by JAMK.

Despite these limitations, this thesis aims to contribute to enhancing the quality of education for logistics and purchasing engineering students at JAMK with feasible solutions.

2 Literature Review

2.1 Enterprise Resource Planning System

2.1.1 History

Before ERP systems, organizations relied on a patchwork of unconnected computer programs for their key business activities, including finance, supply chain, human resources, and production. This created bottlenecks, hindering efforts to streamline business processes. According to Nestell and Olson (2017), when large businesses introduced personal computers in the 1980s and 1990s, many independent software applications were created for use in various departments. Organizational efficiency was hampered by this fragmentation, which led to redundant work and inconsistent data. Acknowledging this problem, SAP created an ERP system that integrates multiple applications into one platform, offering a comprehensive perspective on the performance of the operation. Following suit, other businesses developed their own ERP systems. Both Oracle and PeopleSoft concentrated on creating robust database and human resources solutions at the same time (Nestell and Olson, 2017).

Despite being one of the fastest developing, largest, and most significant commercial software products today, ERP systems demand has fluctuated throughout history due to factors such as cost and market segmentation. Research into ERP systems has a long history. Nestell and Olson (2017, p. 2) explained before 2000, ERP systems were exclusive to large enterprises due to high costs, often exceeding five million dollars. In the late 1990s, Y2K concerns drove increased demand for ERP systems as businesses sought solutions to address potential issues related to the year 2000 when the date format transitioned from two to four digits. This fueled a surge in ERP acquisitions for Y2K preparedness. After 2000, demand dropped, leading to market changes. Oracle acquired PeopleSoft, Microsoft consolidated products into Dynamics for small businesses, and SAP remained dominant in large enterprises. Other ERP systems, such as Compiere, emerged, and local markets in China and India thrived. SAP and Oracle maintained global influence. Post-2000, the ERP landscape

saw consolidation, diversification, and the coexistence of global and local solutions (Nestell and Olson, 2017). The ERP software market has undergone a remarkable transformation throughout its four-decade history.

2.1.2 Business Operation Influence

ERP systems have emerged as a critical software solution for business operations. Functioning as a central information repository, ERP integrates data from diverse departments, fostering a holistic view of the organization's performance. This centralized data empowers leadership to make data-driven choices informed by real-time insights across various functionalities, including finance, manufacturing, and customer relationship management. Nowadays, ERP systems are constantly innovating, integrating new technologies to handle a wider array of business functions, as companies become more reliant on them for core operations. WGR (2018) reported in Statista that the global cloud ERP market is predicted to grow 13.6% annually and achieve $40.5 billion by 2025. The exponential growth track of the ERP software market necessitates a commensurate expansion of the skilled workforce capable of implementing, managing, and utilizing these complex systems effectively.

The initial ERP systems were primarily focused on back-office operations, providing automation for tasks such as accounting, inventory management, production, order processing, and so on. However, as businesses grew more complex and interconnected, the need for integrated ERP solutions that could encompass a wider range of functions became increasingly apparent. Gheorghiu (2024) stated that after interviewing 225 companies who were all looking for ERP, “the breakdown of companies in our business sample, by industry, was as follows: manufacturing (47%), distribution (18%), services (12%), construction (4%), retail (3%), utilities (3%), government (3%), healthcare (3%), and other (10%). However, to complicate matters a little, 20% of manufacturers also manage distribution and some distributors include light manufacturing in their operations, like assembly.” ERP systems have grown far beyond traditional back-office tasks, now encompassing a wider range of functionalities. They seamlessly integrate front-office operations alongside core functions. ERP systems bridge the gap between purchasing and logistics, enabling data-driven decisions for optimized procurement and efficient fulfillment.

The ERP market has broadened with many developers and suppliers. In a study investigating ERP vendors' market share, Weinberg (2022) reports the top 10 most commanding ERP vendors today including SAP, Salesforce, Workday, Microsoft, Sage, Oracle, Infor, Epicor, ServiceNow, and QAD. This is consistent with the data obtained by Vailshery (2023), with more than 11 percent of the global ERP software market and 29,000 domains, Microsoft Dynamics is one of the industry leaders (see Figure 1). This software program helps clients migrate from outdated ERP systems to a cloud-based solution. It is a complete business management solution from Microsoft for small and medium-sized enterprises. Besides that, SAP and SAP ERP obtained nearly 8 percent and 6 percent of the ERP software market share respectively (see Figure 1). SAP refers to the entire suite of enterprise software applications that SAP offers, while SAP ERP is a specific ERP product within that suite. SAP ERP is most used by large enterprises, while SAP's other products may be more appropriate for smaller businesses. In general, those numbers make SAP one of the largest and most influential ERP vendors globally. After over 50 years, SAP continues to be a leader in the ERP market, offering a wide range of enterprise software solutions that help businesses of all sizes manage their operations more effectively. SAP is well-positioned to continue to be a leader in the ERP market for many years to come.

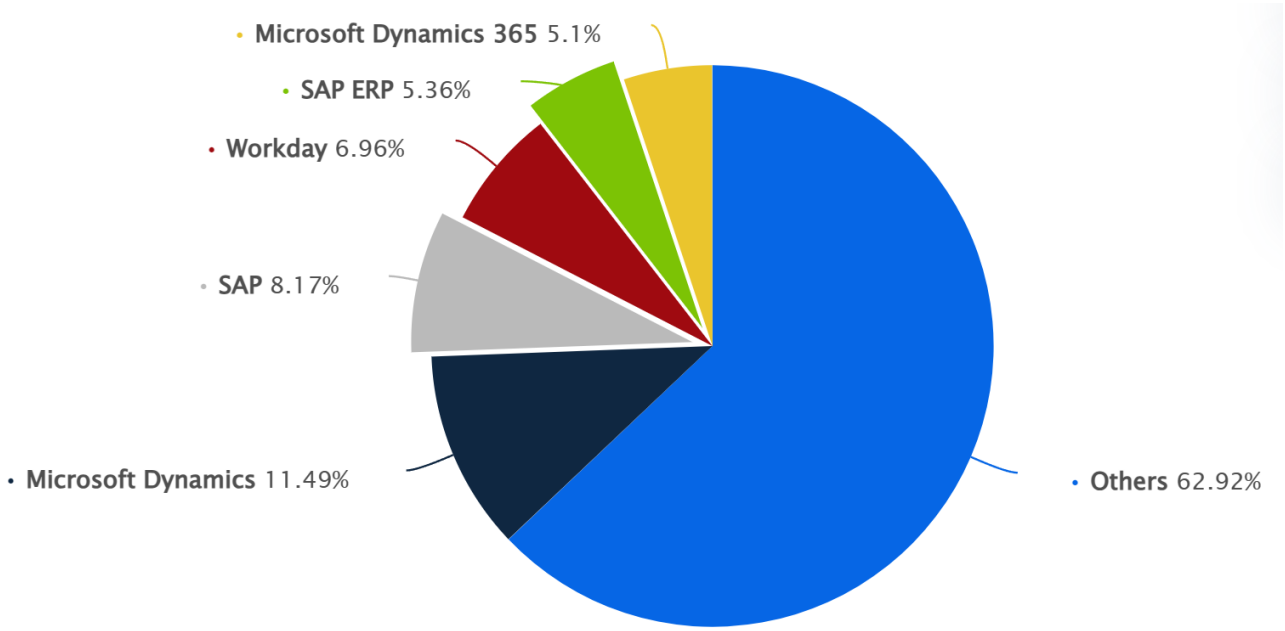

Figure 1. Market share of leading enterprise resource planning (ERP) software companies worldwide in 2023. Statista.

2.2 SAP - SAP Cloud ERP

SAP, a crucial player in the ERP market, offers a complete suite of integrated solutions catering to large and complex businesses. SAP is a company that started as a small team of five people in 1972. Now, it is a multinational enterprise with more than 105,000 employees and headquarters in Walldorf, Germany. SAP is the origin of the company's German name: Systemanalyse Programmentwicklung, which translates to System Analysis Program Development (SAP, n.d).

SAP played a pioneering role in developing and popularizing ERP systems. SAP (n.d) accentuates that they created the global standard for ERP software with its primary SAP R/2 and SAP R/3 software. Nowadays, ERP is enhanced to the innovational level of SAP S/4HANA by processing enormous data and supporting modern innovations such as artificial intelligence and machine learning using in-memory computing (SAP, n.d). SAP (n.d) clarifies SAP S/4 HANA stands for SAP Business Suite 4 the HANA Database. It is the latest generation of SAP business suite software - SAP Enterprise Central Component (SAP ECC). SAP S/4HANA Cloud, being an integrated and intelligent ERP system, encompasses a wide range of modules, covering various aspects of business operations.

Depending on the needs of each organization and industry focus, they can choose to use one or more core modules including finance, controlling, sales, procurement, manufacturing, supply chain, and project management. SAP (n.d) reported they also offer a range of solutions beyond SAP S/4HANA Cloud ERP, including the Business Technology Platform for integrated technologies. Through the SAP Business Technology Platform, SAP S/4 HANA can be simply integrated with other SAP and third-party applications. It is also easy for non-developers to make customizations and enhancements through apps which will be stable through future release upgrades. In addition, artificial intelligence is embedded across the suite. Furthermore, Supply Chain Management, Financial Management, Customer Relationship Management and Customer Experience, Spend Management, Human Capital Management, and industry-specific solutions cater to diverse needs. SAP's Business Network enhances collaboration. Together, these solutions create a comprehensive ecosystem for efficient business operations.

Figure 2 illustrates the ERP cloud portfolio of SAP. According to SAP Learning (n.d), SAP S/4 HANA Cloud ERP is the core of SAP's cloud portfolio. SAP Business Technology Platform supports the Cloud

ERP as a foundation for customers to differentiate their businesses live via integrations and extensions. Surrounding the Cloud ERP and SAP Business Technology Platform are industry-leading business applications and Line of Business (LoB) that jointly offer an extensive suite of agile business solutions that mostly only SAP can provide. Beyond what is offered in the SAP S/4 HANA Cloud ERP, customers can find additional capabilities in Human Capital Management, Spend Management & Business Network, and Customer Relationship Management (see Figure 2).

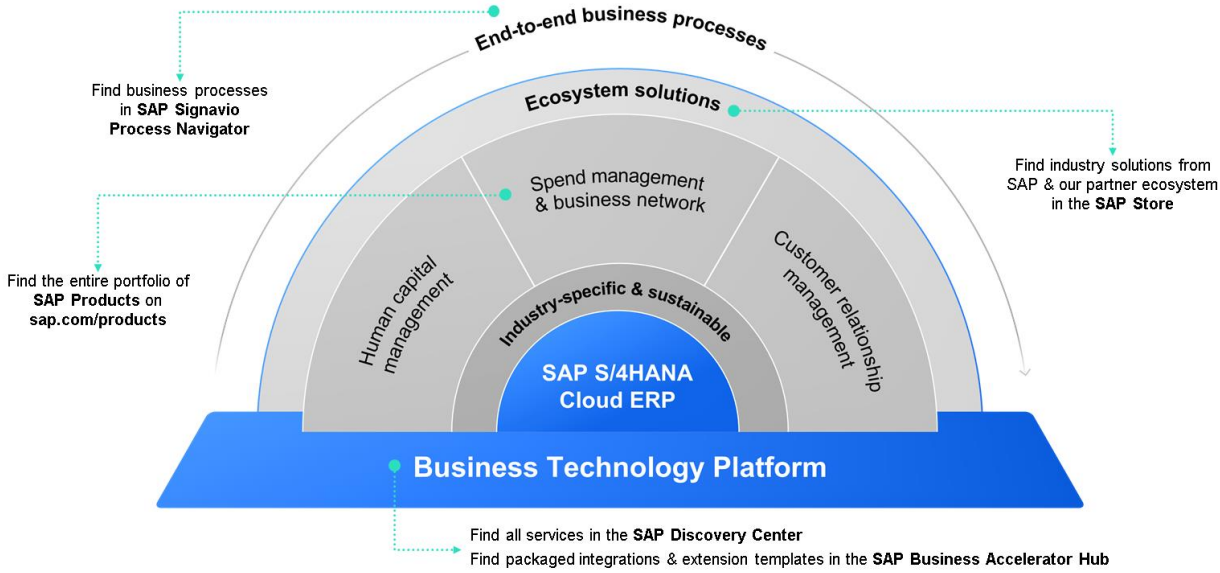

Figure 2. SAP's Cloud ERP Portfolio. SAP Learning.

Lines of Business (LoB) include human resources, sales, service, sourcing & procurement, R&D engineering, manufacturing, supply chain, and asset management. These are the sub-processes categorized into four core End-to-End Business Processes – Recruit to Retire, Lead to Cash, Source to Pay, and Plan to Fulfill (see Figure 3) (SAP leaning, n.d).

Recruit to Retire is one of the vital business processes needed in every company regardless of scale, industry, and location. This process helps companies manage the entire human capital lifecycle, from attracting and onboarding talent to developing skills, tracking performance, keeping healthy, and ultimately facilitating a smooth transition to retirement. SAP provides data-driven insights for

understanding, managing, and optimizing all aspects of the workforce (internal and external workers) in line with business objectives, and with a clear financial impact (SAP learning, n.d).

Lead to Cash is an end-to-end business scenario that focuses on customer experience. It streamlines the entire journey from initial interaction in the Sales line of business, to order fulfillment, delivery process, to revenue realization. The procedures can be expanded or modified following a customer's unique needs by leveraging SAP. They can also differ depending on the kind of industry, the kind of clients, and the sales channel (direct sales or e-commerce) that is utilized (SAP learning, n.d).

Source to Pay aims to maximize the impact and potential of the Sourcing & Procurement LoB's end-to-end sourcing and procurement processes by utilizing core data, predictive analytics, and machine learning to ensure that the right suppliers are selected for direct materials, indirect materials, and services. Millions of suppliers are available for buyers to connect with, and buyers may profitably connect with suppliers to effectively manage their cash flow and sales cycle. SAP S/4HANA Cloud and SAP Ariba both include business processes that enable end users to source and purchase products with ease (SAP Learning, n.d).

Plan to Fulfill is a set of end-to-end business procedures that allow businesses to manage a robust, sustainable digital supply chain that includes all business operations associated with product planning, manufacture, and delivery. Customers experience a responsive and customer-centric supply chain through business processes in the Manufacturing, R&D Engineering, Supply Chain, and Asset Management LoBs. These processes represent the foundation of a resilient organization. SAP S/4HANA Cloud offers solutions for both discrete and process manufacturing (SAP Learning, n.d).

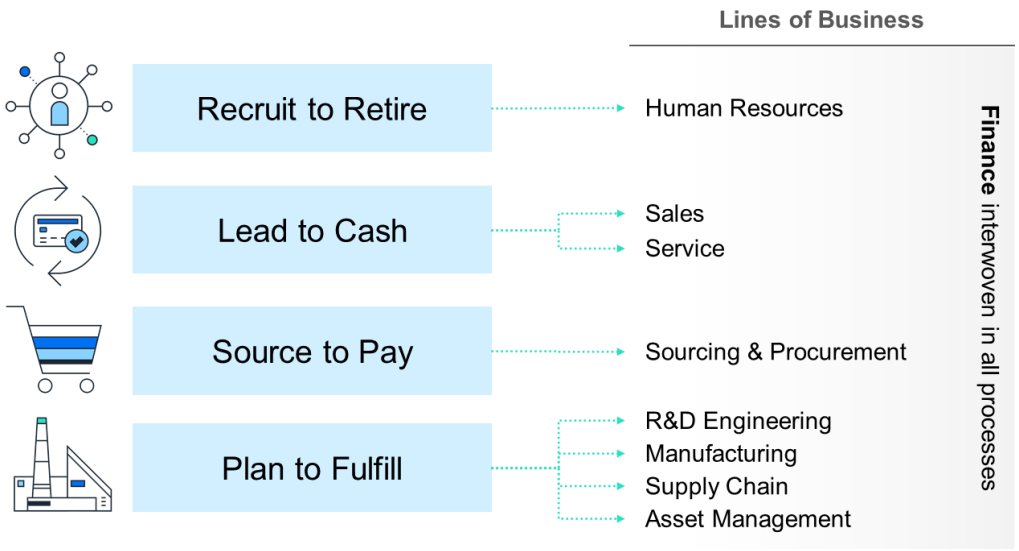

Figure 3. Core End-to-End Business Processes. SAP Learning.

2.3 SAP S/4 HANA Foundational Concepts

Foundational concepts refer to the fundamental principles and terminology that form the basis of SAP Cloud ERP, a comprehensive system. Understanding these concepts is essential for students/juniors who want to work with SAP ERP Cloud as a major part of their jobs or pursue a career in SAP as they provide insight into how the system is structured and how it can be effectively leveraged to support business operations.

2.3.1 Cloud Computing

SAP Cloud ERP leverages cloud computing to deliver its ERP software. SAP Learning (n.d) describes delivering apps, platforms, operating systems, data storage, and other computing resources over the Internet is known as cloud computing (see Figure 4). To simplify, the utilization of resources such as water, electricity, and internet access is defined by a model in which individuals do not possess ownership over the underlying infrastructure such as power plants or water treatment facilities. Instead, people access these essential services through a network, paying for the specific quantities consumed (SAP Learning, n.d). Similarly, cloud computing adheres to a comparable paradigm, in which computational resources, encompassing storage, processing capabilities, and software applications, are provisioned on a demand-driven basis via internet connectivity.

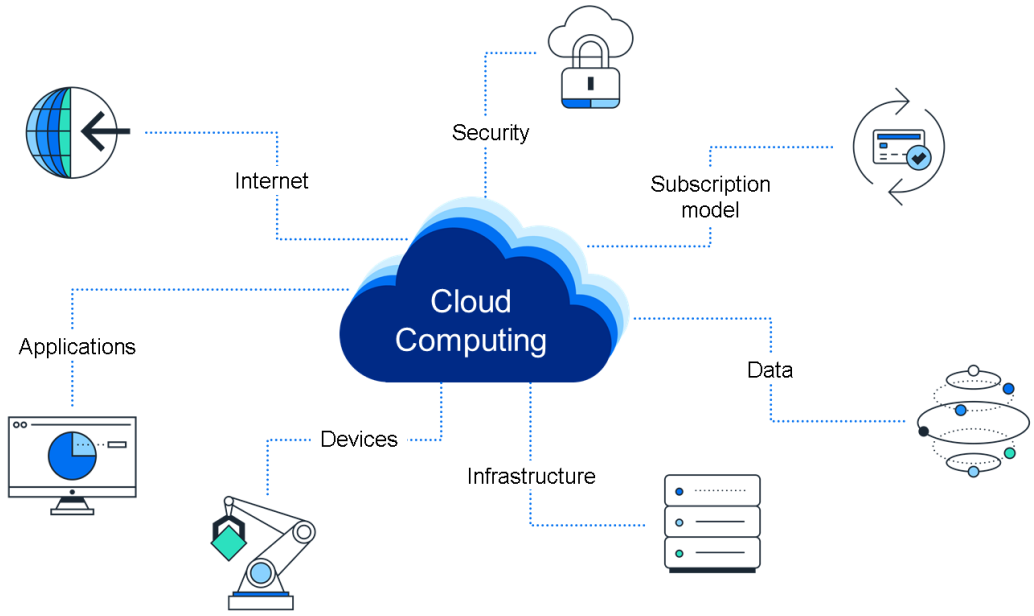

Figure 4. Foundational Concepts of Cloud Computing. SAP learning.

In the National Institute of Standards and Technology (NIST) Definition of Cloud Computing, Mell and Grance (2011) defined that the cloud model is composed of five essential characteristics, four deployment models, and three service models.

Mell and Grance (2011) explained that essential characteristics include first, **on-demand self-service** which enables autonomous provisioning of computing resources, such as server time and network storage, without direct personnel intervention. Second, **broad network access** is a characteristic that facilitates worldwide access to cloud capabilities through standardized mechanisms, accommodating diverse client platforms such as mobile phones, tablets, laptops, and workstations. Third, another characteristic is **resource pooling** - within a multi-tenant model. It means that providers bring together computing resources to meet varying customer demands. Clients can select service locations at a higher abstraction level (for instance, country or datacenter), but lack precise control or knowledge of specific service locations. This affords customers a perceived geographic independence, with resources including memory, computing power, storage, and network bandwidth. Fourth, **rapid elasticity** facilitates the dynamic scaling of computing capabilities, both outward and inward, in response to varying demand levels. This elasticity is often automated, allowing for the swift provisioning and release of resources. Last, **measured service** involves automatic monitoring, control, and optimization of resource utilization through metering, providing transparency for efficient management and cost control (Mell & Grance, 2011).

Development models were stated in the NIST Definition of Cloud Computing as *private, community cloud, public cloud, and hybrid cloud*. In **a private cloud**, exclusive cloud infrastructure is provided for the singular use of a single organization, encompassing many consumers or business groups. Ownership, management, and operation may reside with the organization, a third party, or a collaborative arrangement with on or off-premises infrastructure. **Community cloud** in which exclusive cloud infrastructure is supplied for the use of a particular community of consumers from organizations that have similar concerns about mission, security requirements, policy, and compliance considerations). One or more of the organizations in the community, a third party, or some combination of them can own, manage, and operate the community cloud infrastructure which can exist on or off premises. And **public cloud** where the cloud infrastructure is provided for open utilization by the general public. A business, academic, or government organization, or some combination of them is allowed to own, manage, and operate the infrastructure that exists on the cloud provider's premises. Besides that, a **hybrid cloud** is a cloud infrastructure that includes two or more distinct cloud infrastructures (private, community, public) bound together for data and application portability, utilizing standardized or proprietary technology (Mell & Grance, 2011).

Service models include *Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS)*.

In **Software as a Service (SaaS)**, consumers utilize provider-hosted applications on cloud infrastructure - the collection of hardware and software that facilitate five essential characteristics of cloud computing. The applications are accessible from diverse client devices through client interfaces such as web browsers or program interfaces and the SaaS provider is constantly developing new enhancements and features with the latest technology. The consumer lacks management or control over the fundamental cloud infrastructure except for limited users who have specific application configuration settings. SAP’s public cloud SaaS solutions are regularly updated in all the customer systems. For SAP S/4 HANA Cloud, a Private Edition solution, SAP manages the technical upgrade processes but puts it up to each customer individually to determine when they are ready for an upgrade to be implemented which is required at least once every 5 years (Mell & Grance, 2011).

In **Platform as a Service (PaaS)**, consumers utilize a cloud provider's platform to deploy their consumer-created or acquired applications. This deployment is conducted over the Internet and involves applications developed using programming languages, tools, services, and libraries supported by the PaaS provider. PaaS offers a comprehensive environment that facilitates the development,

testing, and application enhancement without the need for customers to manage the underlying infrastructure, including network, servers, and operating systems but they have control over the deployed applications and possibly configuration settings for the application-hosting environment (Mell & Grance, 2011).

Infrastructure as a Service (IaaS) is when consumers are provisioned with fundamental computing resources such as storage, processing, networks, and/or other virtual computing resources. They can deploy and run operating systems and applications. While the consumer lacks control over the underlying cloud infrastructure, they can command operating systems, storage, and deployed applications, with limited control over select networking components such as host firewalls (Mell & Grance, 2011).

Figure 5 illustrates the SAP solutions mapped to computing services. SAP S/4HANA Cloud - ERP software supports customers in managing their core business activities across the areas of Finance, Sourcing and Procurement, Sales, Professional Services, R&D Engineering, Manufacturing, Supply Chain, Transportation Management, and Warehouse Management. SAP S/4HANA is the solution, and it can be deployed in a public cloud (SAP S/4HANA Cloud Public Edition), a private cloud (SAP S/4HANA Cloud Private Edition), or on-premises (SAP S/4 HANA) (see Figure 6).

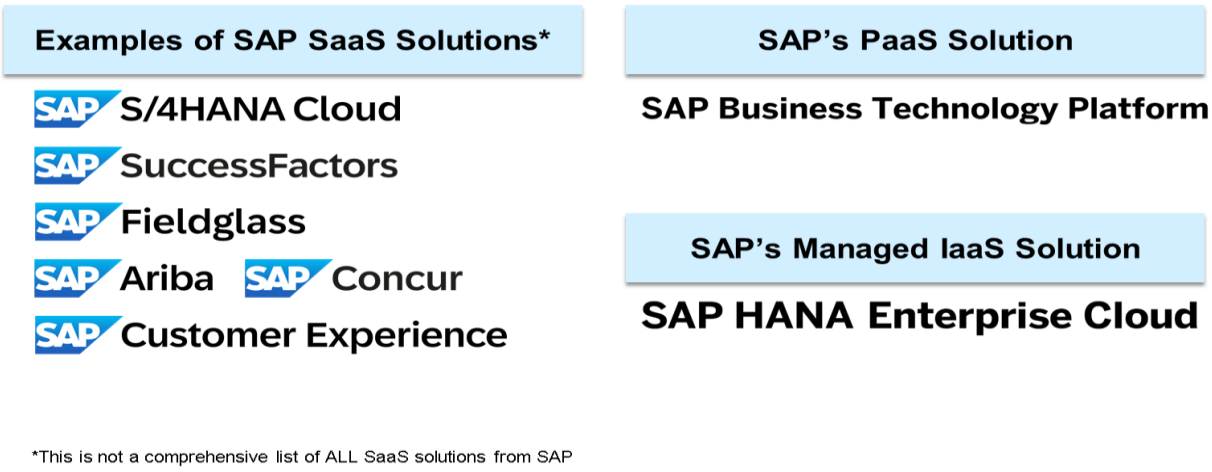

Figure 5. SAP solutions mapped to computing services. SAP Learning.

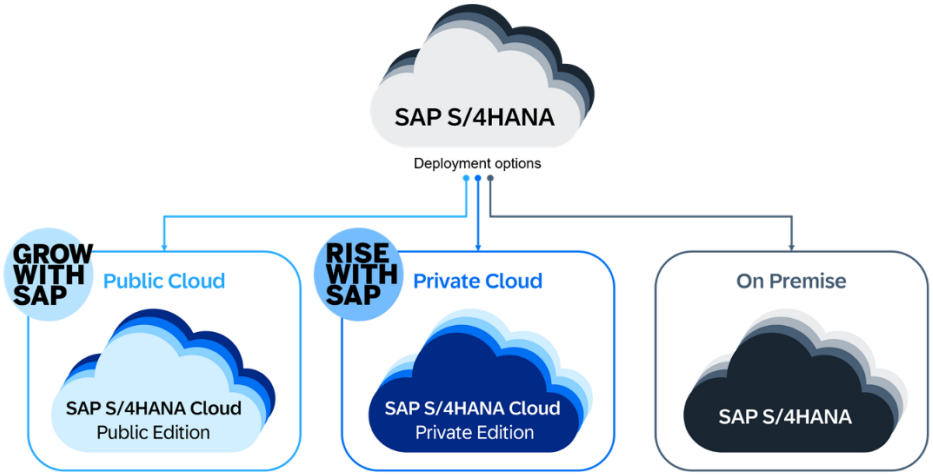

Figure 6. SAP S/4 HANA development models. SAP Learning.

GROW with SAP is the enablement package that comes with the SAP S/4HANA Cloud Public Edition software for small and midsize businesses looking for an instant solution. In other words, SAP S/4HANA Cloud Public Edition users can get results immediately with ready-to-work business processes based on proven industry best practices. Semi-annual release updates in August and February, which SAP installs automatically in the system on the dates specified in the release plan, help businesses remain ahead of the curve by providing them with the newest business procedures and technological advancements. Organizations can readily tailor business processes to their specific needs via a fully extensible platform, ensuring functionalities align with unique operational requirements with the cloud architecture (SAP Learning, n.d).

RISE with SAP is the enablement package accompanying the SAP S/4HANA Cloud Private Edition software which is targeted for SAP's installed base customers migrating to the cloud. SAP S/4HANA Cloud Private Edition enables users to migrate to the cloud at their own pace. A comprehensive library of ready-to-run business processes makes it simple to start from the beginning, while customization flexibility allows businesses to create highly customized business processes that meet the requirements of the industry. SAP provides annual updates so that users may keep up to date on the newest developments while still having the flexibility to implement new features at their own pace (SAP Learning, n.d).

Both SAP S/4HANA Cloud Private Edition and SAP S/4HANA (on-premise) have the same functional scope, which includes support for all 25 industries, annual updates, and end-to-end line of business

operations. The license model (subscription or perpetual) and the location of the infrastructure (on-site or in a distant data center) are the primary variations between the two. Additionally, after purchasing the on-premise deployment, SAP S/4HANA clients are not required to install updates. Customers using the private edition need to commit to standard maintenance, a requirement for at least one update every five years (SAP Learning, n.d).

2.3.2 Client/Server Architecture

The work of computing between 'clients' and 'servers' is divided by Client/Server architecture. SAP S/4 HANA's architecture was designed to meet the dynamic needs of modern businesses with a cloud-native architecture, which differs from traditional client/server architectures. In the cloud environment, SAP utilizes a multi-tiered architecture, and the client-server model is adapted to suit the distributed nature of cloud computing. It consists of a presentation layer, application layer, and database layer (see Figure 7) (SAP Learning, n.d). Figure 7 retrieved from SAP Learning (n.d) illustrates the architecture of SAP S/4HANA. It contains SAP Fiori Launchpad user interface, SAP Business Suite software, Core Data Services analytical layer, and SAP HANA database respectively from top to bottom.

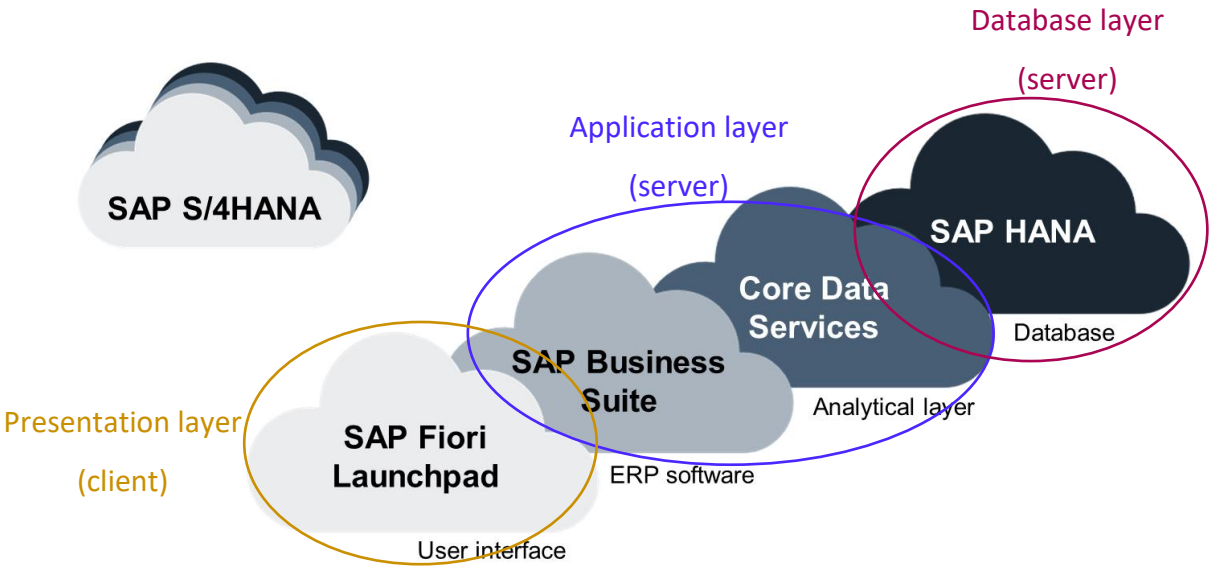

Figure 7. SAP S/4 HANA architecture. SAP Learning.

The **SAP Fiori launchpad** serves as a graphical user interface (GUI) shell specifically designed to integrate and manage SAP Fiori applications. Functioning as the primary access point for these applications on both mobile and desktop devices, the launchpad offers a centralized platform for user interaction. An employee's individual home page (see Figure 8), referred to as the launchpad, allows them to see and use applications that are authorized for the role(s) they have been assigned (SAP Learning, n.d). According to SAP Fiori Launchpad (n.d), the SAP Fiori Launchpad home page offers a canvas of tiles and links, allowing users to curate their app access by adding, removing, or grouping them for a personalized launch experience.

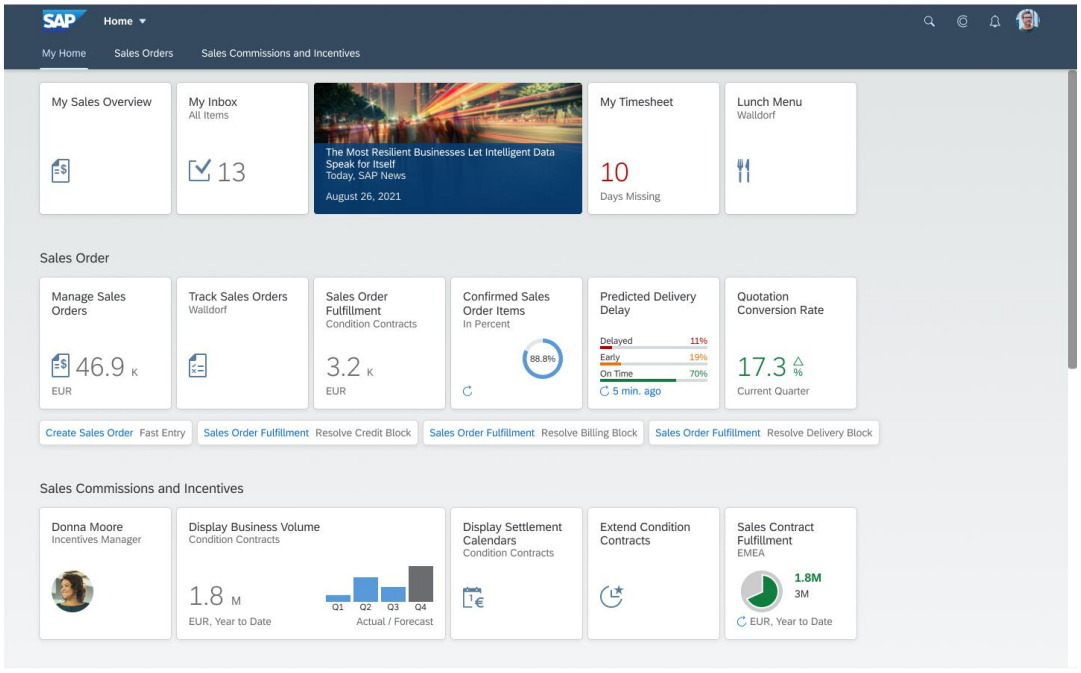

Figure 8. SAP Fiori launchpad - home page. SAP Fiori Launchpad.

The **SAP Business Suite software** and **Core Data Services (CDS) analytical layer** are constructed on the SAP HANA database. CDS is a crucial component within SAP S/4HANA to define a consistent data model for various applications within S/4HANA and to create analytical views and reports based on the defined data model. On the other words, CDS views can be created to model data from the database for analytical tasks as well as to generate application programming interfaces (APIs) to allow other applications to consume the data. SAP Learning (n.d) describes "CDS layer provides a universal language to read and process data across different applications". CDS acts as a core component within S/4HANA, facilitating data management, access, and application development.

The **SAP HANA database** plays a central role in the SAP S/4HANA architecture by serving as its foundation for data storage, processing, and analytics. According to SAP, SAP HANA stands for SAP High-performance Analytic Appliance, which is an in-memory, column-oriented database designed to store, receive, and query data. SAP (n.d) also defined SAP HANA Cloud as "An in-memory database as a database type that stores data in a computer's main memory (RAM - random access memory) instead of on traditional disks or solid-state drives". Utilizing main memory for data storage offers substantial performance gains in data retrieval, consequently accelerating queries and processing tasks, leading to faster decision-making and a data-driven approach. Besides that, column-oriented databases also excel at fast and precise data retrieval for analytics because they only access relevant data (columns) for queries instead of casting a wide net. This efficiency, combined with in-memory storage, allows SAP HANA to handle massive datasets needed for advanced analytics, machine learning, and AI applications in a faster and more precise way (SAP Learning, n.d). The SAP HANA database acts as the engine that powers the speed, efficiency, and real-time capabilities of SAP S/4HANA. It supplies a unified platform for data management, analytics, and application development, fostering a data-driven approach to modern business operations. This explains why after being launched in 2010, SAP HANA became outstanding in the market.

2.4 SAP Ecosystems

SAP has succeeded in establishing a strong ERP market and leading the entire industry. The SAP business environment is not as simple as a vendor and customers. It is a vast and complex network of players that interact with and contribute to the success of SAP software and solutions. This created an enormous and dynamic SAP ecosystem including SAP itself; partners - independent companies that develop and sell complementary software solutions, provide implementation and consulting services, and support SAP software; customers - SAP users; universities and research institutions - who collaborate with SAP to develop new technologies and train future generations of SAP professionals; industry associations and user groups - a platform for SAP users to share knowledge, network, and learn from each other.

2.4.1 Business Partners

The business partner approach proves valuable in the digital era by promoting customer-oriented, collaboration, agility, and efficiency, which are all important aspects for businesses competing in a

dynamic and data-driven environment. In 2015, when SAP built and launched a new generation of ERP with SAP S/4HANA, the business partner data model was identified as a vital transformational cornerstone to support organizations in their goals to advance industry borders and gain significantly higher flexibility (Akhtar, 2022). By understanding the local needs of customers and SAP products, the gap between SAP's offerings and the specific requirements of customers in different regions is narrowed by partners. They also bring deep industry-specific expertise to the table by developing and offering specialized solutions tailored to the unique requirements of different industries, complementing SAP's core offerings (Akhtar, 2022). Particularly, consulting service partners help businesses with the design, development, implementation, and integration of SAP solutions via strategic business consulting expertise. Software solution partners develop and offer complementary software solutions that integrate with SAP products which extend the functionality of SAP solutions and cater to specific industry needs. Technology partners provide hardware, infrastructure, and other technology solutions that support SAP software.

Besides that, leveraging the business partner approach helps SAP scale its operations without significantly increasing internal resources. Partners handle implementation, customization, and ongoing support for many customers, freeing up SAP's resources to focus on core product development. In other words, SAP’s partners help businesses to leverage the full potential of SAP solutions and achieve their digital transformation goals, this leads to improved customer satisfaction and loyalty (SAP, n.d). This ecosystem is a win-win for both SAP and its partners. It allows SAP to offer a wider range of solutions and services to its customers, while also helping partners to grow their businesses.

Even though SAP can free up its resources in some departments, they have continuously provided knowledge boundary resources for its partners. SAP needs to ensure its partners are equipped with extensive knowledge about solution systems. Kauschinger et al (2023) studied the different knowledge resources available in the SAP ecosystem. They include openSAP, SAP Community, SAP Developer Portal, SAP employees, SAP Help Portal, SAP Learning Hub, SAP on GitHub, SAP Partner Edge, SAP Press, SAP Support Portal, SAP Training, SAP events and conferences, SAP YouTube Channel, Blogs by hobbyists, Videos by hobbyists, User group meetings, Implementation guidelines, Coworkers, and Company-internal wikis. This proves that SAP not only relies on its partners to deliver its products but also puts significant effort into providing resources to support its partners.

2.4.2 SAP Customers

SAP reported in its Global Corporate Communications in early 2024 that “85 of the 100 largest companies in the world are SAP S/4 HANA customers” and “87% of total global commerce generated by SAP customers”. With the largest cloud portfolio – more than 100 solutions for all lines of business (LoB) as well as software suites, SAP is leading the market share in enterprise applications software, enterprise resource management applications, supply chain management applications, procurement applications software, travel and expense management software, and ERP software. In Finland, the City of Turku's Aura project has successfully switched its ERP to a cloud-based SAP S/4HANA solution and implemented the most modern ERP system in Finnish public administration. Alma Media Oyj - one of the largest media companies in Finland has satisfyingly replaced its legacy ERP system with SAP S/4 HANA with a smoother and more efficient financial closing process (SAP, n.d). There are many more successful stories of SAP customers around the world.

The increased adoption of SAP ERP systems has resulted in a significant rise in demand for SAP expertise across multiple industries. With a background in purchasing and logistics, acquiring SAP ERP skills makes people highly competitive candidates. Because many companies are actively seeking individuals who understand both the technical aspects of SAP and the knowledge of procurement and supply chain management.

2.4.3 Universities and Academia

Universities and Academia play a crucial role in SAP ecosystems. It is a visional strategy to nurture the next generation of SAP professionals and strengthen the overall ecosystem. The SAP University Alliances is a program for academic institutions to engage in SAP events, create industry collaborations, educate the next generation about the Intelligent Enterprise and the experience economy, and prepare graduates for the SAP ecosystem. SAP University Competence Centers (UCCs) and Academic Competence Centers (ACCs) are part of the SAP University Alliances network. They are essentially service centers set up at universities that are members of the program. SAP (n.d) reported in its Next-Gen community, more than 500 institutions are collaborating with SAP all over the world. In Finland, apart from JAMK, 25 universities and universities of applied sciences are members of SAP University Alliances.

Leveraging all the valuable offers from SAP University Alliances can enhance student's academic outcomes. University members gain access to SAP Learning Hub, a comprehensive online platform with interactive courses, tutorials, and simulations for SAP software. This allows for flexible and engaging learning experiences for students. Additionally, some universities with full membership are eligible for access to SAP S/4HANA systems, the latest ERP offering, for in-class exercises and projects via ERPSim, SAP in the classroom, and so on. The program also supports students in preparing for industry-recognized SAP certifications, both through learning resources and potentially cloud-based practice environments. With SAP certifications, students are closer to the competitive industry labor market. On top of that, SAP offers dedicated onboarding training to help faculty members get familiar with the resources and effectively integrate them into their curriculum. In conclusion, the program empowers universities to effectively prepare students for success in the SAP ecosystem (SAP Learning, 2023).

Another key benefit of the SAP University Alliances program for universities is the access to learning pathways by solution. Learning pathways by solution provide SAP knowledge and hands-on solution experience through different courses and projects with clear, comprehensive, and pre-defined learning paths. Discover is the first stage of the learning path. In the next stage – exploration, students start to be aware of SAP while educators prepare for workshops and connection with the educator community. Academic is one of the most important stages where students get introductory, and educators get ready for classroom use. It is followed by the deep dive stage where students build skills via team projects, hackathons, and so on while educators deeply concentrate on customer projects and SAP learning. The last stage is certification (See Figure 8). All solutions have their own comprehensive and specific details for learning pathways. For example, there are learning pathways for SAP S/4 HANA consultants, learning pathways for data analysts in SAP Analytics Cloud, etc.

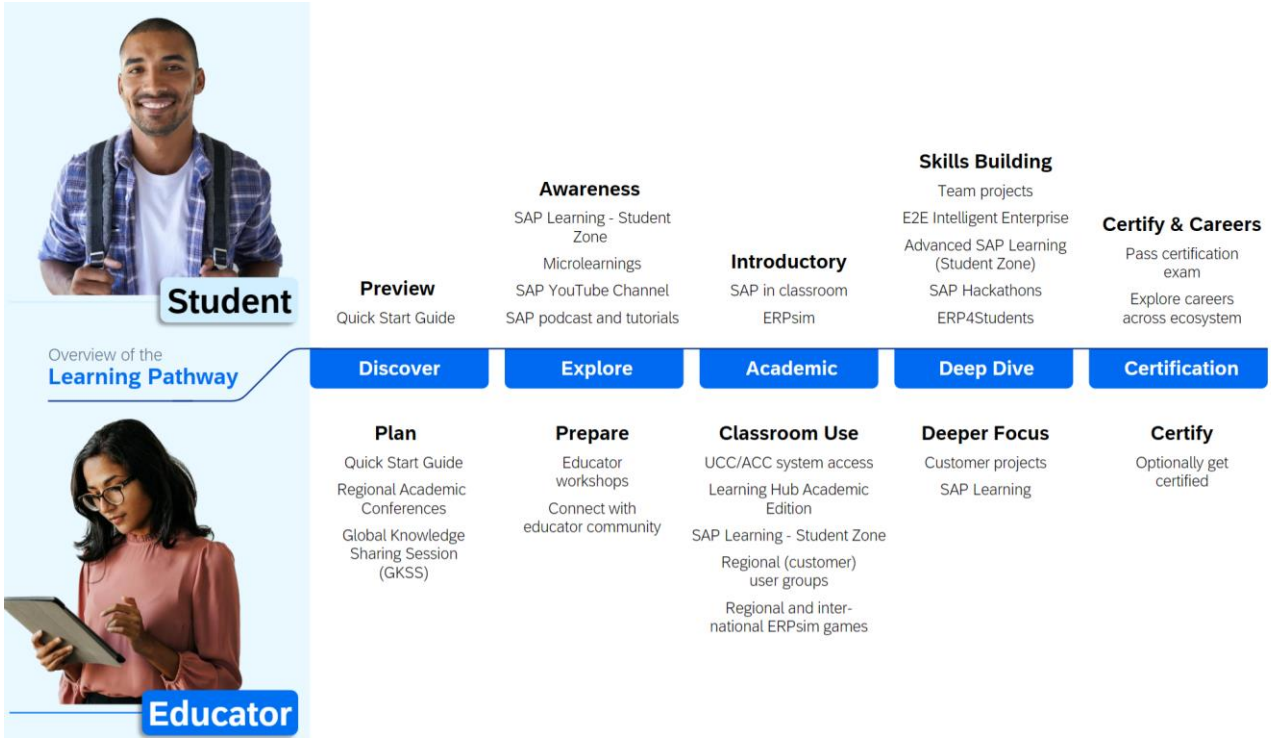

Figure 9. Overview of Learning Pathway for both Student and Educator. SAP.

2.4.4 Industry Associations and User Groups

The SAP User Groups are an important independent part of SAP´s ecosystem, they help customers to connect, collaborate, learn, exchange ideas, give feedback, and make the most out of their investment in SAP solutions. SAP local user groups are supported by the SAP Global User Groups organization which actively engages in strategic planning, communication, and showcasing innovations to ensure that SAP users are well-informed, involved in shaping the future of SAP products, and can leverage the latest advancements in their respective fields.

According to SAP (n.d), there are 42 local user groups located in North America, Latin America, Europe, Asia Pacific Japan, and Africa. There are 18 groups in Europe. Finland: The Finnish-speaking User Group (FINUG) is one of them. 156 organizations in Finland including SAP customers and users, SAP partners and partner companies, and independent consultants who all work with the use, implementation, and sales of the software are connecting, promoting collaboration, and ensuring a two-way dialogue between its members and SAP via FINUG. With more than 50 annual events including seminars, working groups, theme evenings and mornings, webinars, etc, members can share experiences and practical information related to SAP implementations ongoing development needs, and business process improvements (SAP FiNUG, n.d). In other words, FINUG acts as a valuable platform for Finnish SAP users to connect, share knowledge, and influence the development of SAP

products and services. JAMK is utilizing the benefit of FINUG membership by encouraging and supporting students to participate in events such as ERPsim Finnish Championships where students not only connect with the SAP community through participating organizations and the SAP Finnish User Group but also gain visibility for JAMK.

3 ERP and Logistics Simulation courses

This chapter introduces the courses' mission, content, and learning objectives, outlining the industry's core requirements that necessitated their curriculum integration. It further establishes a foundation for analyzing potential differences between students' acquired knowledge and the specific skill sets demanded within the purchasing and logistics industry.

Besides that, it also highlights the innovative curricula employed by JAMK's ERP and Logistics Simulation courses. The courses emphasize active learning methodologies, incorporating simulations and case studies to foster a more engaging and practical learning experience for students. This aligns with the findings of Hackathorn et al. (2011), whose research suggests that in-class activities are demonstrably more effective in promoting student achievement compared to traditional lecture formats.

A study by Andera (2008) found that Central Michigan University (CMU) graduates with a Logistics Management major who took SAP classes earned a significantly higher starting salary ($40,500) compared to those who did not ($34,750) in 2004 -2005 (see Figure 10). This suggests that SAP skills can give CMU business graduates a competitive edge in the job market, particularly in the logistics field. Cronan and Douglas (2012) make a similar point in their study of salary data comparisons for business students who enrolled in ERP classes versus all graduates from a mid-size U.S. university. They emphasize: "Students who enrolled in an ERP fundamentals course experienced higher salaries compared to all business graduates (on average); as much as 20% greater median salary for 2008 and 11% greater median salary for 2010". These suggest similar benefits for JAMK graduates. The ERP and Logistics Simulation courses provide hands-on SAP experience through SAP S/4HANA. In

other words, this helps JAMK students not only be outstanding in the job market but also likely to get higher-paid jobs.

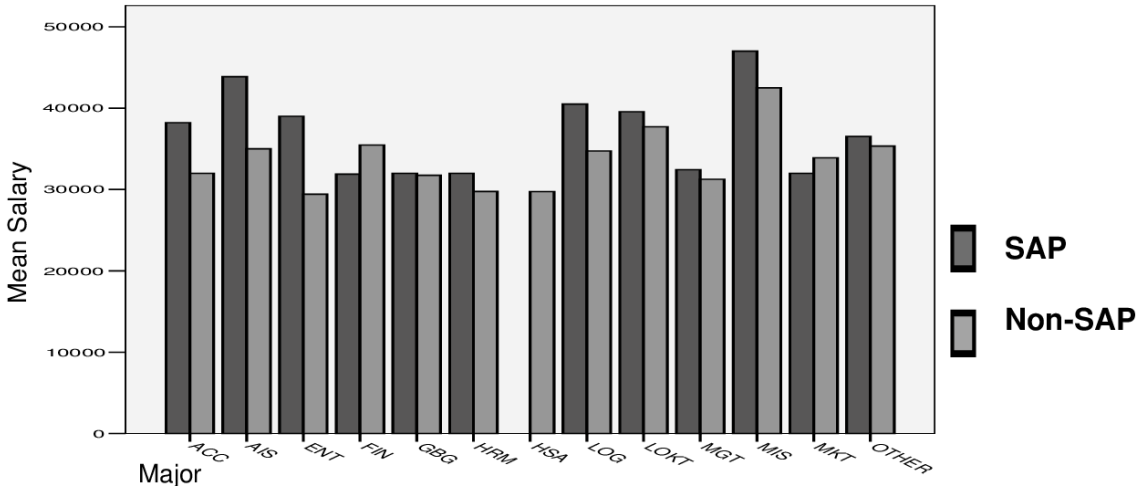

Figure 10. Salary Comparison of Graduates by Majors SAP vs. Non-SAP 2004-2005 Major.

3.1 ERP – Enterprise Resource Planning Course

ERP systems have become global within the contemporary business landscape, serving as a cornerstone for integrated management of an organization's core resources. The ERP course offers a comprehensive exploration of this vital domain, equipping students with a thorough understanding of ERP's theoretical underpinnings and practical applications. Boykin and Martz (2004) emphasized there's a strong connection between logistics and ERP systems because both involve understanding and working with business processes. They also accentuated that integrating ERP concepts into the logistics curriculum can help students develop process-oriented thinking, which is crucial in today's business environment.

The ERP course at JAMK is a compulsory 5-credit course that is under technology criteria in the purchasing and logistics engineering curriculum. The course has been changed from Enterprise Resource Planning to Enterprise Resource Planning Systems to be more precise. According to the JAMK curricula (n.d), the ERP course is planned to be conducted in the third semester with the prerequisites of completing the World of Logistics course which is supposed to be completed after the first

semester. World of Logistics course provides participants with a strong grasp of the entire logistics ecosystem, including its trends, its role in a circular economy, and the various functions that work together to ensure the seamless flow of goods. In other words, while the World of Logistics course provides knowledge in different logistical processes such as purchasing, warehousing, production, and transportation, the ERP course enhances students' knowledge of ERP systems to manage those processes more effectively.

This course offers a student-centric approach to understanding ERP systems. JAMK curricula (n.d) specifies the course is connected to the SAP University Competence Center. It combines traditional lectures with engaging case studies and practical exercises, fostering a holistic learning experience. Lectures provide the theoretical foundation, introducing core ERP concepts such as their purpose, data management techniques, underlying technologies, and their impact on business processes. Additionally, lectures explore the concept of business process re-engineering and the multiplicities of implementing ERP systems. In terms of case studies and exercises, the course utilizes a fictitious company, Global Bike. Global Bike serves as a relatable scenario, simulating the daily operations of a medium-sized manufacturing company (SAP UCC, n.d). By immersing students in realistic situations, they gain a practical understanding of how employees interact with the SAP S/4HANA system as they navigate typical business tasks and transactions via the SAP Fiori Launchpad user interface. Furthermore, a key strength of this course lies in its modular structure. This modular design allows instructors to customize the course sequence and to be flexible and adaptable within academic settings (SAP UCC, n.d).

This course requires students to invest approximately 135 hours to complete case studies and exercises based on the Global Bike company. The course is mostly conducted via an online environment and self-study. With a pass/fail evaluation, students must actively engage with the provided materials to successfully navigate processes (Line of Business - LoB) such as sell – fulfillment, buy – procurement, make – production, track – financial accounting, track – controlling, people – human capital management, store – inventory and warehouse management, maintain – enterprise asset management, service – customer service, and project – project management. While some lectures delve into one chosen case study, students must independently tackle at least three others within the limited timeframe by following instruction materials. To gauge student mastery of the course content, instructors utilize exams and reports to assess their learning outcomes.

3.2 Logistics Simulations Course

Building upon the foundation of the World of Logistics and ERP Systems courses, the purchasing and logistics engineering curricula offer an advanced course called Logistics Simulations. Successful completion of both prerequisites is required for enrollment. Utilizing the SAP environment, particularly SAP S/4HANA, this course elevates students to a more complex business sphere. Working in teams, they navigate simulated real-world business environments, learning to plan strategies, manage virtual companies, analyze situations, and make real-time decisions – all within a realistic and dynamic setting. This demanding Pass/Fail course requires a significant time investment of approximately 135 hours by attending classes, playing simulation games, and doing group assignments.

The Logistics Simulations course, inspired by the SAP University Competence Center, leverages the immersive ERPSim platform - developed by HEC Montreal in Canada. This business simulation platform, designed for SAP S/4HANA, offers a progressive learning experience through four distinct scenarios. Ranging from a fundamental distribution company to a complex B2B manufacturing plant, these scenarios encompass a total of eleven games with escalating difficulty levels (ERPsim Lab, n.d). The game structure delves into various areas such as manufacturing (introductory, extended, advanced, and sustainable), logistics (introductory, platinum, advanced, and sustainable), and procurement (maple introduction, retail introduction, and retail extended). Each game simulates a dynamic market, demanding strategic adaptation. ERPSim streamlines tasks to focus on decision-making and teamwork. Operating on an accelerated timescale (one game day = one real-time minute), players react rapidly to market fluctuations. Every action triggers processes and provides immediate changes, highlighting interdependencies and fostering a practical grasp of integrated business processes (Léger, 2006). Ultimately, ERPSim provides a valuable tool for students to comprehend complex business concepts realistically and engagingly.

Students are divided into groups of 4-5 people. Each group is an independent company fully accountable for its profits and losses. Based on their virtual company valuation, it defines the winner. Due to time constraints, not all simulation games can be played within the course. The instructor will choose specific games based on the student group, course schedule, and desired learning objectives. However, the weekly schedule of the course is planned according to Table 1.

Table 1. Logistics Simulation Weekly Schedule

Week	Content	Facilities
1	Course and Game 1 introduction	Classroom
2	Game 1 - Logistics	Zoom
3	Game 1 - Logistics	Zoom
4	Seminar 1 and Introduction to Game 2	Classroom
5	Game 2 - Manufacturing	Zoom
6	Game 2 - Manufacturing	Zoom
7	Holiday	
8	Game 2 - Manufacturing	Zoom
9	Game 2 - Manufacturing	Zoom
10	Seminar 2 and Introduction to Game 3	Classroom
11	Game 3 - Manufacturing	Zoom
12	Game 3 - Manufacturing	Zoom
13	Game 3 - Manufacturing	Zoom
14	Final Seminar	Classroom

4 Implementation

Building upon the foundation laid in previous chapters, which explored the contemporary state of ERP systems, specifically SAP S/4 HANA, its significance, and a case study of ERP-related courses offered at JAMK, this chapter delves into a critical gap. The focus here is on the potential disconnect between the knowledge acquired by students enrolled in ERP-related courses and the specific skill sets demanded by the purchasing and logistics industry which is also the courses' learning outcomes.

To investigate this gap, on top of studying the literature review, the thesis employs a mixed methods approach, utilizing both quantitative and qualitative data collection methods. A survey (appendix 1) was distributed to the target population – 70 students who have completed the ERP and/or Logistics Simulation courses – to gather both quantitative and qualitative data on their knowledge of SAP ERP systems on the 15th of March. This data provides a statistical overview of their understanding. Furthermore, to gain deeper insights into the specific skills and knowledge students may lack compared

to industry expectations, the thesis also incorporates qualitative data collection through interviews with 2 students (appendix 2) and 3 industry experts (appendix 3) during April. These interviews provide valuable in-depth perspectives on the industry's needs and potential shortcomings in student preparation.

The combined analysis of quantitative and qualitative data will offer a comprehensive understanding of the existing gap between educational offerings and industry requirements. This triangulation of findings will allow for the development of targeted recommendations for enhancing ERP-related curricula at JAMK University. As McKim (2017) argues, mixed methods research leads to deeper, richer insights compared to purely quantitative or qualitative studies. This is because the approach leverages the strengths of both methodologies: quantitative data provides a broad picture through statistics, while qualitative data offers in-depth explanations and contextual details. By employing a mixed methods approach, this thesis aims to achieve a nuanced understanding of the skills gap and propose effective solutions for curricula development.

5 Results

5.1 Quantitative Data

The survey includes both quantitative (ratings) and qualitative (open-ended) questions. The survey's objective is not only a statistical visualization of the effectiveness of ERP and Logistics Simulation courses but also the deeper thoughts of students about their study experiences and improvement idea generation. In terms of quantitative data, the survey was created to measure how much the courses' learning objectives are met from students' perspectives. Questions are generated in a way that students can honestly and easily rely on their perspectives by rating their learning experiences and outcomes from 1 – strongly disagree to 5 – strongly agree.

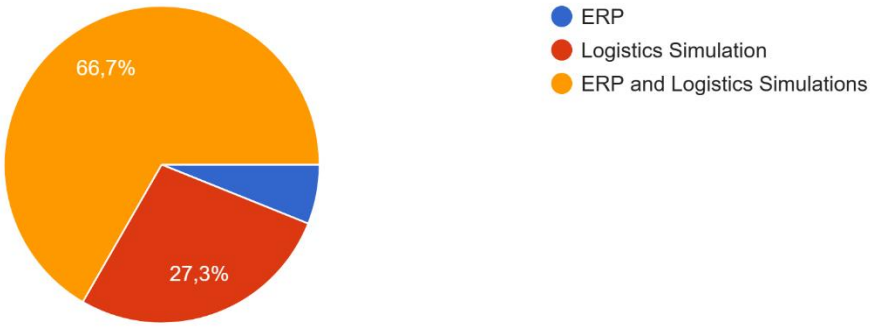

Figure 11. Percentage of respondents in ERP-related courses survey.

From the 15th of March to the 15th of April, the survey was distributed to 70 students, of which n=33 (47.1%) respondents participated in at least one course related to ERP. Among these respondents, the majority (n_1=22, 66.7% of respondents) had taken both ERP and Logistics Simulation courses. A significant portion (n_2=9, 27.3% of respondents) participated solely in Logistics Simulation, while a smaller group (n_3=2 students (6.1% of respondents) focused exclusively on only ERP. There is no overlap between n_1, n_2, and n_3. Figure 11 provides a visual representation of this breakdown.

There are two sets of statements that are related to the ERP course (statements 1 to 7) and the Logistics Simulation course (statements 8 to 12). The first question of the survey helps to identify the sample group and assign respondents a suitable set of statements. Table 2 presents the results for all statements. Respondents rated their agreement with each statement on a scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The table shows the distribution of responses across these rating options for each question. A higher number of responses in these five categories (1- strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, and 5 - strongly agree) suggests a stronger level of agreement with the statement.

There are three sub-groups of the sample, therefore, the result is reported comparatively between n_1 and n_3, as well as n_1 and n_2. Because students who participated in both courses have a deeper understanding of the SAP system and potentially different perspectives on specific concepts compared to the other groups. However, the analysis does not mainly focus on the differences but the main goal of evaluating the effectiveness of ERP and Logistics Simulation courses via average points of ratings.

n_1 and n_3 – ERP

Despite the difference in sample sizes between n_1 and n_3, around 80% (19/24) of respondents from both groups agreed or strongly agreed with statements 1 and 2. This suggests a solid understanding among students in both groups regarding the foundational concepts of ERP systems. Statements 1 and 2 respectively addressed basic topics such as the purposes of ERP implementation in organizations and commonly used ERP systems in the market. Statements 3 through 7 assessed students' understanding of technical components, stakeholders, implementation processes, and the Global Bike case studies. While the average ratings for these statements ranged positively between 3.7 and 4.0, a small number of respondents still chose 'strongly disagree' or 'disagree.' This suggests that

some students might benefit from further development or clarification regarding the core technical components of ERP systems (statement 3), the key stakeholders involved in implementation (statement 4), the concepts of ERP implementation (statement 5), and the learning outcomes from the Global Bike case studies (statements 6 and 7). Suggested ideas for improvement are collected through qualitative research methods, which are explained in more detail in the next session.

n_1 and n_2 – Logistics Simulation

The high average ratings for statements 8 (4.16) and 12 (4.19) indicate that students generally found the simulation games to be a valuable way to learn about business strategy and processes and believe the skills and knowledge gained apply to their future careers. However, statements 9, 10, and 11 have lower average ratings of 3.74, 3.87 and 3.87 respectively. The results recommend that some students might have found the knowledge base, instructions, or scenario explanations lacking in clarity or detail. This could be an area for further development in the course materials. It is hard to have any solid conclusion about the courses' effectiveness only via quantitative data.

Therefore, qualitative data were collected to not only gather suggestions for development but also to solidify the results of statistical data.

Table 2. Quantitative data was collected from a survey.

	Statements/Ratings	1	2	3	4	5	n	aver-age
ERP	1. I am confident that I can identify how ERP helps organizations align operational activities with strategic goals for managing resources and improving efficiency.	-	-	-	1	1	n_3=2	4.04
		-	-	5	12	5	n_1=22	
	2. I am confident that I know some well-known ERP systems in the market such as SAP, Oracle, Sage, Microsoft, Infor, etc.	-	-	-	1	1	n_3=2	4.04
		-	3	1	11	7	n_1=22	
	3. I am confident that I understand the core technical components of an ERP system such as client/server architecture, user interface, ERP software, analytical layer, and database.	-	-	-	-	2	n_3=2	3.79
		-	2	7	9	4	n_1=22	
	4. I am confident that I can identify the key stakeholders (key users, main users, end users, consultants, technical specialists, application specialists, programmers) involved in an ERP implementation and their respective roles.	-	-	-	-	2	n_3=2	3.96
		-	1	9	4	8	n_1=22	
	5. I am confident that I can outline the key steps involved in planning an ERP implementation project (system pre-study and comparison, workshops, simulations, conversions, interfaces, training, and so on).	-	-	-	1	1	n_3=2	3.71
		1	2	6	8	5	n_1=22	
	6. I am confident that I understand the structure and layout of the Global Bike teaching and learning environments.	-	-	-	-	2	n_3=2	3.83
		-	1	8	9	4	n_1=22	
	7. I am confident that I can apply some basic knowledge and skills in SAP systems after completing some of the Global Bike case studies such as fulfillment, procurement, production, financial accounting, controlling, human capital management, inventory, warehouse management, v.v into practice.	-	-	-	-	2	n_3=2	3.88
		-	2	7	7	6	n_1=22	

Table 2 is continued next page.

Table 2. Quantitative data was collected from a survey (continuation).

Logistics Simulation Course	8. I think it is a great way of playing simulation games in the SAP environment (particularly in SAP S/4 HANA) to learn about business strategy and processes.	-	1	-	5	3	n_2=9	4.16
		-	-	3	6	13	n_1=22	
	9. I have enough knowledge base, instructions, and well-explained simulation scenarios to manage my virtual company in simulation games.	-	-	2	6	1	n_2=9	3.74
		-	2	8	7	5	n_1=22	
	10. I have learned some critical skills in analyzing business situations and making real-time decisions after playing simulation games.	-	-	1	7	1	n_2=9	3.87
		-	-	8	10	4	n_1=22	
	11. I believe that using a real SAP S/4HANA system with actual transactions to evaluate, input, and see the result of my/my team's decisions brings me closer to what an ERP user would experience in the workplace.	-	-	2	7	-	n_2=9	3.87
		-	-	8	8	6	n_1=22	
	12. I believe that the skills and knowledge I gained after this course are helpful and applicable to my future career.	-	1	1	5	2	n_2=9	4.19
		-	-	2	11	9	n_1=22	

5.2 Qualitative Data

5.2.1 Survey

This thesis employs a mixed methods approach to gain a comprehensive understanding of student experiences with ERP and Logistics Simulation courses. Quantitative data was collected through a survey, while qualitative insights were gathered through student interviews conducted in April. Following Brannen (2016), the numerical data from the survey is used to generate questions for the interviews, allowing to explore the 'why' behind the survey findings. Additionally, open-ended survey questions provided students with an opportunity to elaborate on their experiences and suggest areas for course improvement. In this session, the results of these open-ended survey questions are reported according to three sub-groups of a sample (n_1=22, n_2=9, and n_3=2).

Building on the open-ended survey questions, the design encouraged respondents to not only choose from suggested course improvement ideas but also to propose their own. Similar to quantitative data, qualitative data is reported in a parallel way between n_1 and n_3 for the ERP course and n_1 and n_2 for the Logistics Simulation course. The result shows the level of support for pre-listed suggestions and also captures additional proposals generated by these respondents. Figure 12 presents the data of 24 students (n_1 and n_3) ideas on how to improve the ERP course while Figure 13 displays the results for 31 students (n_1 and n_2) for the Logistics Simulation course improvement suggestion. Analyzing these figures is crucial for identifying the most promising solutions for course development, which aligns with the overall goal of this thesis.

Figure 12 shows that two-thirds (16/24) of students who completed the ERP course felt the case studies required more explanation and detail in each transaction and step. One student commented that the course seemed to require minimal effort to succeed, suggesting the case studies could benefit from more complexity - "For now, the course looks like "easy credits", as students do not need any "brain work", we just follow the steps in the guideline, some students don't even read what are steps about".Additionally, 50% of respondents supported the idea of having tests on SAP knowledge and skills after completing the case studies. There were also some minor suggestions for different improvements, such as enhancing the clarity of course content and the Global Bike case studies or providing and suggesting more materials.

Figure 13 presents suggestions from students in groups n_1 and n_2 for developing the Logistics Simulation course. The most prominent suggestion focused on improving the clarity and comprehensiveness of the knowledge base, instructions, and simulation scenarios. Around half of the respondents supported the idea of changing the learning environment, integrating data analysis skills into simulation games, playing more rounds in the games, and providing more available materials for those interested in deepening SAP knowledge and skills. Besides that, several comments suggested integrating data analysis skills, such as using oData, into the simulation games. Additionally, students expressed interest in opportunities to deepen their SAP knowledge and skills, perhaps through follow-up courses, online resources, or guest lectures from industry professionals (e.g., FINUG). One comment proposed restricting the course to second-year students who have already completed the ERP course.

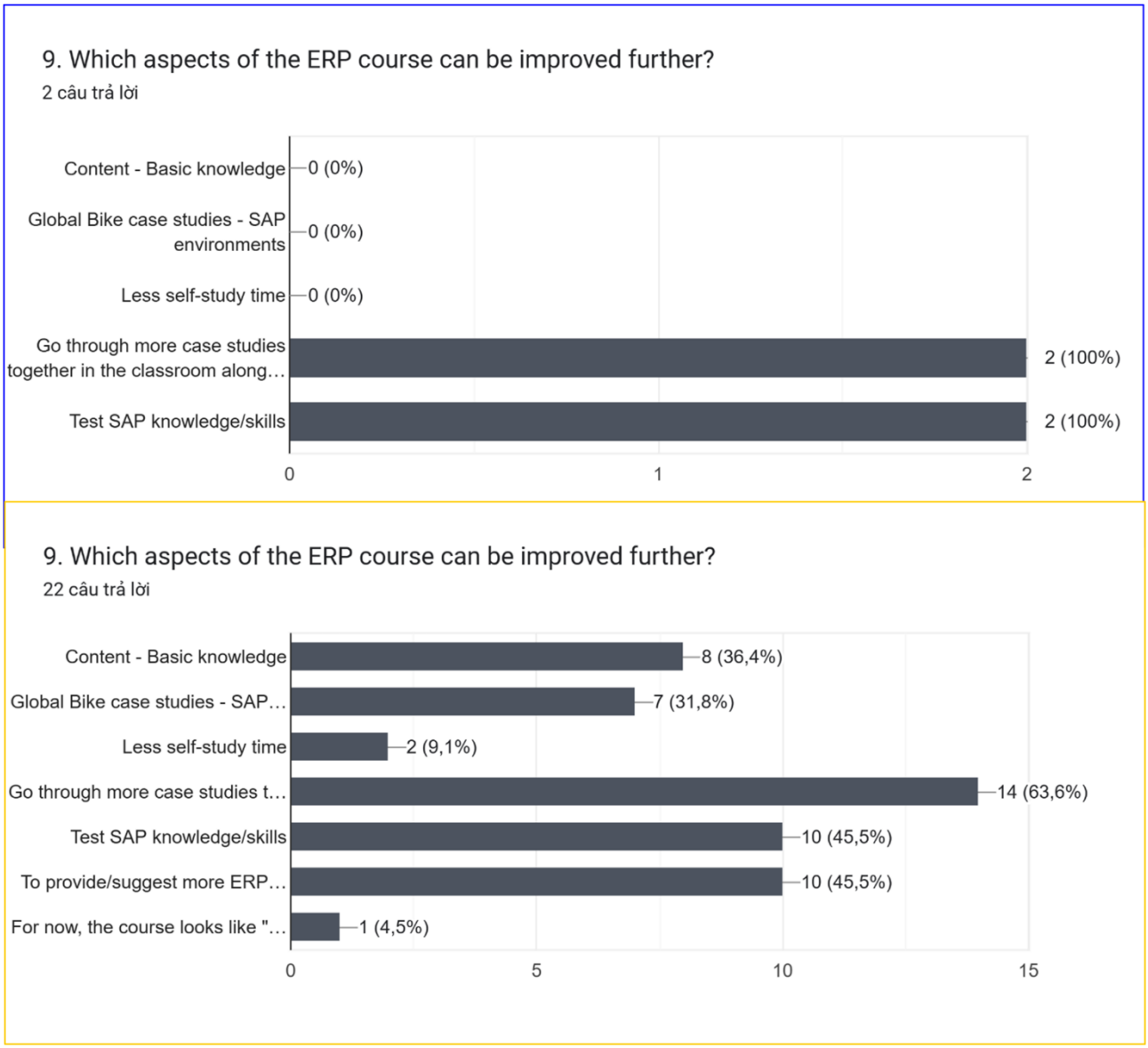

Figure 12. Collected qualitative data from a survey on the ERP course improvement.

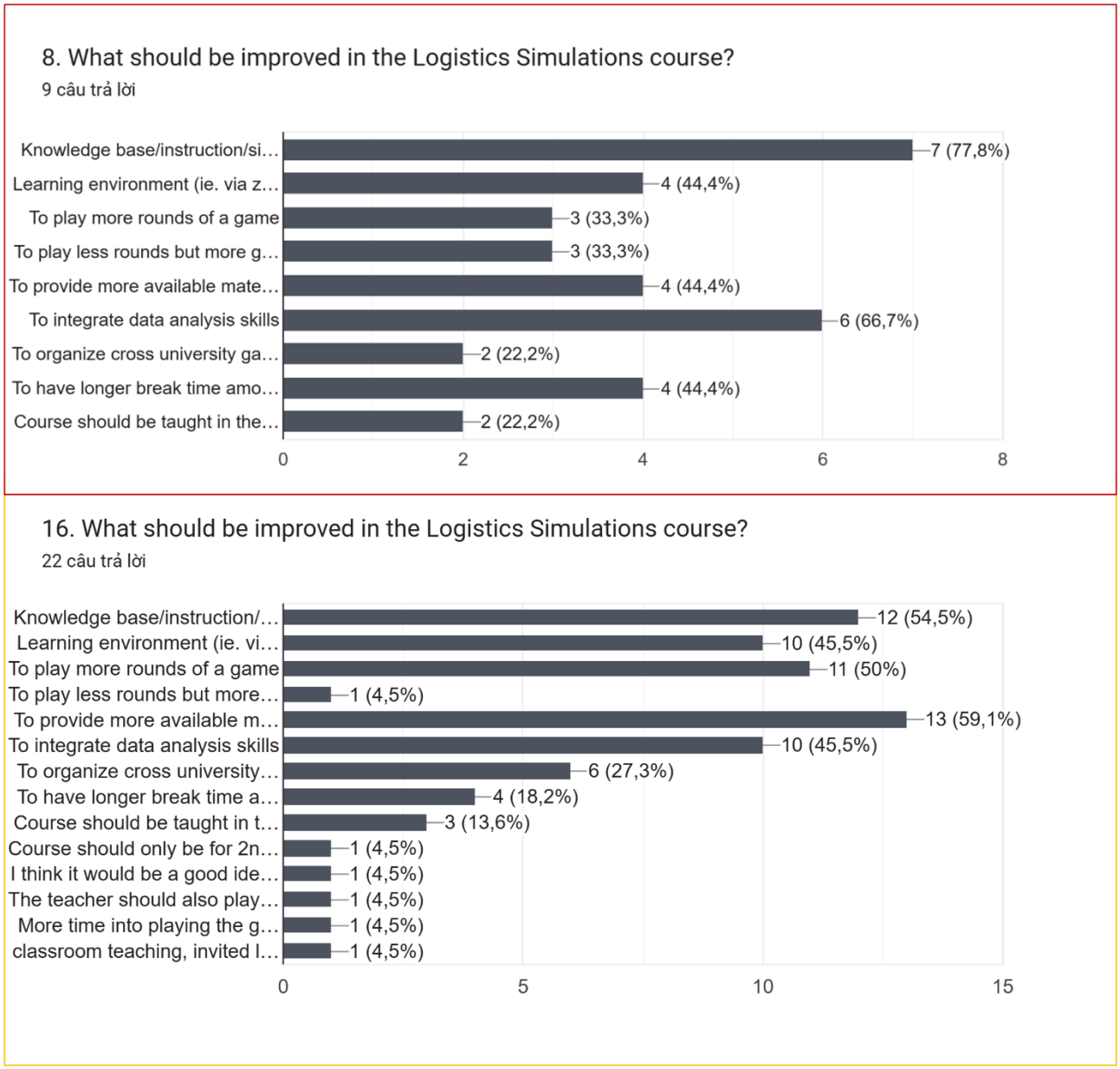

Figure 13. Collected qualitative data from a survey on the Logistics Simulation course improvement.

5.2.2 Interviews

Students

To gain deeper insights, two students from the logistics and purchasing engineering program participated in semi-structured interviews in April. To ensure anonymity and avoid bias, their identities are kept confidential. These students were at different stages in the program, offering diverse perspectives due to their distinct program stages. Student 1 is in the beginning stages of their studies, while Student 2 is nearing program completion. The highlight results of these interviews are presented in parallel for easier comparison and analysis (see Table 3).

Table 3. Qualitative data was collected from student interviews.

Questions	Student 1	Student 2
Completed courses	The World of Logistics, and Logistics Simulation.	The World of Logistics, ERP, and Logistics Simulation. Additionally, Basics of Purchasing, Production, and Materials Management.
What did they answer to the survey question "I think it is a great way of playing simulation games in the SAP environment (particularly in SAP S/4 HANA) to learn about business strategy and processes"? And why?	They gave 2 and they explained that they did not understand the processes to manage their virtual company. They do not know how to plan a clear strategy and how to make a decision based on that strategy and how it affects the company's operation. They just followed the instructions on video to play the games and did not understand what and why they had to input something and get the outputs.	They gave 4 and they emphasized the interest in learning by simulation approach. They had learned and understood the fundamental processes, and by playing they could apply what they had learned to operate their company. However, they were also confused at the beginning when they did not know how to use the system yet. And just by watching the instruction videos, they could not clarify what needed to be done.
What kind of challenges have they faced during the courses?	They found that they were not provided a clear introduction as well as information for playing the game. And it was hectic to have a simulation of one minute per one virtual day. Playing via Zoom also caused challenges for teamwork. And sometimes roles and responsibilities were taken by more than one person.	They found it was fast and confusing at the beginning of each game. They also explained that it was hard to catch up and easy to misunderstand while working with their team via Zoom. They needed to manually export the data to Excel and do some analysis, which took time and effort.

Table 3 is continued next page.

Table 3. Qualitative data was collected from the student interviews (continuation).

How well did they manage to work as a team?	Not well. They evaluated their team dynamic as not good due to the lack of contribution, lack of communication, and lack of responsibility from the teammates, especially in a Zoom environment.	Quite well. They explained their team gathered together at a library to play the games as it solved the problem of misunderstanding and helped to see other's screens on the system and know who did what and how.
What should be improved in the courses?	They suggested that the important information should be remarkably highlighted. The classroom environment makes it easier to catch up with the games and their team. The games should be a bit slower. It would be great to have more materials and resources provided for those who are interested.	They expressed a strong interest in somehow combining data analysis with the Logistics Simulation Course. They highlighted the importance of oData (an open protocol for querying and updating data using web services) but noted it wasn't covered in the courses. They also wished to go deeper into SAP systems with more advanced courses or at least direction (e.g. online platforms for self-learning, available materials, certificates, etc).
From 1-5, how would they rate their study experiences in general?	They gave 2 as they explained they did not get the actual expected outcomes of simulation games as well as team building skills.	They gave 4 since they achieved the process and strategies learning outcome but did not have wise knowledge of the SAP systems which interested them.

Professionals

To prepare students for the market with comprehensive knowledge and competencies, it's vital to study the industry's needs and expectations. Besides the fact that the courses have been built based on industry requirements, additional industry SAP experts interview is a valuable way to collect qualitative data on this topic. Two online interviews were conducted in April with a total of four professionals, each with over 10 years of experience in SAP. These professionals have diverse current backgrounds as consult-ants/solution experts (who advise and implement SAP systems for

companies) with experience as end-users (those who directly interact with the system), and key users (who have in-depth knowledge and influence system configuration) in the past. Furthermore, they all were participants in the ERPsim Finnish Championships 2023 organized by SAP FiNUG. Therefore, they had experience with the Manufacture Advanced simulation game which was used in the Logistics Simulation course, providing valuable insights from a user perspective.

Firstly, when discussing the practicality of the simulation games, the industry experts acknowledged their benefits in terms of business process and strategy education. However, they cautioned that the games alone may not be sufficient to equip students with the full range of knowledge and skills needed to be end-users in the workplace. Since real-life SAP systems include various modules and versions, the simulated environment can differ significantly. Despite this limitation, the experts agreed that students who have been exposed to the system through simulation games are likely to have an advantage in learning and working more deeply with SAP systems in a real work environment.

Secondly, they shared their experiences with the Manufacturing Advanced simulation game. Although they work with SAP systems in their daily working life, the simulated system is not familiar to them. They had the same thought as the students that the game was quite hectic with 20 minutes per round for 20 simulation days. Besides that, they debated that at the beginning, it was difficult to get along with the team while playing remotely. One of them even said that they sometimes just played the games by following what was described in the job aids or instruction videos without really understanding what they were doing due to a lack of specialization understanding. They emphasized the game is good at teaching students a macro picture of business operations. Furthermore, they suggested that utilizing the data from the simulated system to analyze and understand the features behind the system is a great idea for students to gain wide knowledge about the SAP system.

Lastly, when asked about the requirements and expected competencies from entry-level employees for SAP systems knowledge and skills, all the experts agreed that the vastness of SAP systems makes it unrealistic to expect fresh graduates to be well-equipped with comprehensive knowledge and skills. However, they emphasized the importance of students understanding fundamental ERP systems knowledge, such as the benefits these systems offer and how they impact an organization's structure, strategy, business processes, reporting control, and decision-making. They commented

that it is an advantage for those who understand the architecture of an ERP system. They also have experience with the SAP Fiori user interface as a plus, emphasizing the importance of a continuous learning attitude as ERP systems, particularly SAP, are constantly evolving.

For purchasing and logistics engineering majors specifically, the experts agreed that there's a high possibility for graduates to work as SAP end-users. These roles require an understanding of some basic transactions within the system, such as creating supplier profiles, monitoring Bills of Materials, running material requirements planning (MRP), etc. However, a solid grasp of the principles and theory of their major remains equally important. It is necessary to understand the logic behind the system to be able to manage it intelligently.

6 Discussion

6.1 Conclusion

This chapter briefly highlights answers to the research questions introduced in the introduction. RQ1: Why is it important for purchasing and logistics engineering students to learn about ERP systems, particularly SAP S/4HANA? The knowledge base session provides a comprehensive answer, highlighting the critical role of ERP systems, particularly SAP S/4HANA, in modern purchasing and logistics operations. As explained in the literature review, the vastness of ERP systems and the SAP S/4HANA system underscores the value of students gaining foundational knowledge while still in school.

In short, while the ERP is widely explained in session 2.1 with its history and significant influence on business operations, session 2.2 provides a broad understanding of the SAP Cloud ERP systems with a variety of lines of business and the vastness of integrated systems. Delving deeper into the SAP S/4 HAHA system with the fundamental concept of the cloud infrastructure and the server/client architecture is foundational for the first entry-level graduates. Furthermore, the widespread adoption of these systems and its enormous ecosystems have created a significant demand for professionals with SAP-related expertise. By equipping students with the knowledge and skills to navigate these systems through courses such as ERP and Logistics Simulation, JAMK is preparing graduates to be highly competitive candidates in the job market. Equipping students with these in-demand

skills not only prepares them for successful careers but also strengthens JAMK's reputation for providing high-quality education.

The inclusion of ERP and Logistics Simulation courses in the purchasing and logistics engineering curriculum for years demonstrates JAMK's commitment to staying ahead of industry needs. According to the courses' lecturer, these courses were initially developed based on industry requirements, and this study aims to further refine them based on student learning outcomes and evolving some additional modern industry demands. RQ2: What is the gap between students' knowledge of SAP ERP systems and the industry's requirements? is main for that.

The survey and student interview questions were created based on the potential learning outcomes which are also the industry's basic requirements. Although the ERP course provides students with an understanding of core ERP concepts, their impact on organizations, and knowledge to manage some business processes effectively with SAP S/4HANA, this study still finds a gap between students' achieved learning outcomes and those expectation outcomes of the course - the industry requirements. There are still some constraints to maximize the learning outcomes for students during the course.

Similarly, the Logistics Simulation course provides a valuable foundation for business processes and strategies, basic transactions, an understanding of the SAP S/4HANA system, and familiarity with the system's user interface. However, there is an opportunity to increase the student's learning outcomes which are expected from the course content. While simulation games are a powerful teaching and learning tool, they cannot fully replicate the complexities of real-world SAP systems with various modules and versions. This is further supported by the collected data about the challenges of the limited time frame and unfamiliar simulated environment. Additionally, it is important to understand the information system behind the screen with data mining and analysis skills, which are currently not heavily emphasized in the course. Therefore, this study aims to identify solutions to improve the courses and ensure graduates possess the knowledge and skills required by the industry. This is also the aim of the RQ3: How can ERP and Logistics Simulation courses for purchasing and logistics engineering students, focusing on SAP systems, be continuously developed, updated,

and improved to ensure students possess the necessary knowledge and skills required by the industry? The following sections will delve deeper into potential solutions that are applicable, feasible, and based on the expectations of the commissioner (Appendix 5).

6.2 Solutions

This session presents proposals for the continuous development and improvement of ERP-related courses for purchasing and logistics engineering students. These proposals focus on equipping students with the industry-relevant knowledge and skills identified in previous chapters.

6.2.1 ERP Course

Based on the results of the mixed methods research, the ERP course appears to be successful in achieving its learning outcomes. Students gain a solid foundation in ERP systems and enhance their understanding through case studies focused on the popular SAP S/4HANA system. However, student feedback indicates that there is room for improvement, particularly in the case studies. Several students suggested that the case studies could benefit from more in-depth explanations for each transaction and step to guide students toward the intended learning goals. This study proposes having at least two case studies conducted in the classroom environment, utilizing a 'what? - how? - why?' approach to explain each step. This structure could potentially improve student comprehension of the case study objectives and avoid situations of mindless following. It also narrows the gap between students' knowledge and the industry's requirements as experts emphasize the importance of understanding basic transactions in SAP for entry-level positions. Along the same lines, Boykin and Martz (2004) argued that "the more a student knows about the complex interactions inherent in a business and how to capture those interactions in an ERP, the more employable that student becomes".

In addition to providing more in-depth explanations within the case studies, this research recommends incorporating formative assessments such as quizzes, Kahoot!, or tests after completing the case studies to assess student understanding and reinforce key learning points. Furthermore, some students expressed interest in delving deeper into SAP and exploring potential career paths. To address this, the course could provide and suggest additional materials, for example, about SAP Cloud, the architecture of SAP S/4HANA, for students who want to advance their study of ERP systems and

SAP. Since JAMK is a member of SAP University Alliances, the course can leverage these membership benefits to promote students' access to learning programs and courses offered by SAP. This approach can not only provide students with more knowledge and opportunities but also enhance JAMK's visibility through the active participation of its students. Moreover, as experts accentuated, fostering a continuous learning attitude is crucial as ERP systems, particularly SAP, are constantly evolving.

Additionally, this study suggests considering prerequisites for the ERP course. As a prerequisite, the World of Logistics course equips participants with a strong grasp of the entire logistics ecosystem, including its trends, its role in a circular economy, and the various functions that work together to ensure the seamless flow of goods. Understanding the various logistical processes (e.g., purchasing, warehousing, production, and transportation) offered in the World of Logistics course is crucial before students can fully grasp the role of ERP systems in managing those processes effectively. ERP systems enhance students' knowledge by providing them with the tools to manage these processes more effectively. This aligns with expert expectations, as they emphasize the importance of students understanding fundamental ERP knowledge, such as the benefits these systems offer and how they impact an organization's structure, strategy, business processes, reporting control, and decision-making.

6.2.2 Logistics Simulation Course

Qualitative data collected from student and expert interviews suggests that the Logistics Simulation Course is a valuable tool for teaching and learning business processes and strategies. This aligns with research by Cronan and Douglas (2012) and Setyono and Arnandiansyah (2018) who found that ERP simulation games significantly increased students' knowledge about business processes, enterprise systems management, and SAP basic skills. Students can gain a strong understanding of key business activities within and between functional areas during the simulation games.

However, the data also suggests areas for improvement. Firstly, the most prominent concern was the clarity and comprehensiveness of the knowledge base, instructions, and simulation scenarios. To address this, the course materials, simulation scenarios, and instructions could be revised to ensure they are clear, concise, and provide a strong foundation in relevant concepts. Additionally, the study suggests to consider establishing prerequisites for the Logistics Simulation Course with at least

the ERP course and World of Logistics. It ensures students possess a foundational understanding of procurement, production, and material management concepts. Ideally, students would have completed courses like 'Basic of Procurement' and 'Production and Material Engineering' beforehand as the different learning outcomes from the two student interviews prove. This background knowledge would solidify their understanding of the purpose, inputs, and outputs of transactions encountered in simulation games such as Manufacturing Advanced (e.g., creating Planned Independent Requirements, running MRP, generating purchase orders, and so on).

Secondly, the collected information shows that both students and industry experts find challenges in managing their virtual company with one minute per day and twenty minutes per round in simulation games. The suggestion is to slow down the pace of the games in the first two rounds by extending them by five to ten minutes each. This can help new users digest the rules and better understand the gameplay. Furthermore, it could be more beneficial for students to start the first three-round game in the classroom environment. This allows them to engage and collaborate more effectively with their team. Since the games involve dividing tasks into roles such as sales & marketing, procurement, production, and finance, students have specific responsibilities and manage different transactions within the system. The classroom setting can facilitate communication and interaction, allowing students to understand others' roles and gain system transaction visibility.

Thirdly, to maximize learning, instructors are recommended to facilitate a group discussion or short presentations after the first two rounds. Here, teams can share their strategies and initial learnings with the system display. This allows students to comprehend the game, learn from each other's experiences, and adapt their approaches for the subsequent rounds. As the game emphasizes learning over competition, open sharing of approaches and findings is valuable for all participants. At the end of each game, instead of a group presentation for a seminar, students should write an individual short report to reflect on their learning, team dynamics, and next game preparation. This approach can help ensure all team members actively participate, understand the game's scenarios, and contribute to the team's success. This addresses the student's concerns about some participants not contributing during online sessions. Plus in this way, there will be more time for playing the games since the students have studied in advance the next game scenarios and rules and made initial plans. Additionally, the seminar weeks can be used for playing the games.

Fourthly, as there are many options for games and time limitations for each lesson, choosing the game selection is important for the learning outcomes of the game. The simulation games focus on different aspects of the supply chain. Logistics games primarily engage students in distribution and sales, while retail games emphasize purchasing and sales processes. Manufacturing games equip students with production, materials management, and sales. To gradually increase student complexity and mastery of the SAP S/4HANA system, the simulation games can follow this sequence: **Logistics Introduction** (focusing on sales and distribution with an initial inventory) familiarizes students with the system. **Retail Introduction** builds on this knowledge by emphasizing purchasing and sales planning**. Manufacturing Introduction** adds production complexity, starting with managing existing materials and then progressing to planning and purchasing raw materials. Finally, **Manufacturing Sustainability**, the most challenging game, requires students to manage all aspects of a sustainable manufacturing environment, including production, materials management, purchasing, inventory, warehouses, sales & marketing, and carbon footprint reduction. Table 4 is the proposal for the course schedule with the current selection of the games provided by ERPsim Lab HEC Montréal. They should be flexible and updated to the availabilities and the needs.

Table 4. Improved Logistics Simulations Weekly Schedule

Week	Content	Time management	Facilities
1	To introduce the course, assessment, group forming, system login, and Logistics Introduction Game	90-120 mins	Classroom
2	Logistics Introduction (rounds 1 and 2) + key findings sharing	30 mins login + 25 mins play * 2 rounds + 10 mins between-game break for team's discussion + 30 mins break + 30 mins sharing = 150 mins	Classroom
3	Logistics Introduction (rounds 3, 4, 5, and 6) + individual assignment introduction	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins assignment introduction = 150 mins	Zoom/Classroom
4	Introduction to Retail Introduction Game (rounds 1 and 2) + key findings sharing	30 mins introduction + 25 mins play * 2 rounds + 10 mins between-game break + 30 mins break + 30 mins sharing = 150 mins	Classroom
5	Retail Introduction (rounds 3, 4, 5, and 6) + individual assignment introduction	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins assignment introduction = 150 mins	Zoom/Classroom
6	Introduction to Manufacturing Introduction Game (rounds 1 and 2) + key findings sharing	30 mins introduction + 25 mins play * 2 rounds + 10 mins between-game break + 30 mins break + 30 mins sharing = 150 mins	Classroom
7	Holiday		

Table 4 is continued next page.

Table 4. Improved Logistics Simulations Weekly Schedule (continuation)

8	Manufacturing Introduction (rounds 3, 4, 5, and 6)	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins sharing = 150 mins	Zoom/Classroom
9	Manufacturing Introduction (rounds 7, 8, 9, and 10) + individual assignment introduction	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins assignment introduction = 150 mins	Zoom/Classroom
10	Introduction to Manufacturing Sustainability (rounds 1 and 2) + key findings sharing	30 mins introduction + 25 mins play * 2 rounds + 10 mins between-game break + 30 mins break + 30 mins sharing = 150 mins	Classroom
11	Manufacturing Sustainability (rounds 3, 4, 5, and 6)	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins sharing = 150 mins	Zoom/Classroom
12	Manufacturing Sustainability (rounds 7, 8, 9, and 10) + group assignment introduction	20 mins play * 4 rounds + 10 mins between-game break * 3 times + 30 mins break + 10 mins assignment introduction = 150 mins	Zoom/Classroom
13	Seminar – Group presentation – Learning outcomes	10 - 15 mins/ group presentation	Zoom/Classroom
14	Guest Lecture to inspire SAP career path	120-150 mins	Zoom/Classroom

The individual report after the Logistics Introduction game (end of week 3 deadline) should include the following questions:

Question 1: How did your team divide the duties? Who did what specific tasks? Did everyone contribute equally? Explain any challenges you faced regarding teamwork.

Question 2: Briefly explain the concept of Stock Transfer transactions in the SAP S/4 HANA system.
Question 3: What kind of challenges did you or your team face during the Logistics Introduction game? How did you overcome these challenges?
Question 4: After previewing the introduction video for the Retail Introduction game, what are your initial concerns? Briefly outline a strategy to succeed in the next lesson.

Similarly, the individual report after the Retail Introduction game (end of week 5 deadline) should include the following questions:
Question 1: How did your team divide the tasks? Who did what specific tasks? Did everyone contribute equally? Explain any challenges you faced regarding teamwork.
Question 2: What are the inputs and outputs of the MPR-run transaction?
Question 3: What kind of challenges did you or your team face during the game? How did you overcome these challenges?
Question 4: After previewing the introduction video for the Manufacturing Introduction game, what are your initial concerns? Briefly explain a strategy to succeed in the next lesson.

The individual report after the Manufacturing Introduction game (end of week 9 deadline) should include the following questions:
Question 1: How did your team divide the responsibilities? Who did what specific tasks? Did everyone contribute equally? Explain briefly your team's strengths and weaknesses.
Question 2: How did you utilize the data for analyzing the market preferences and planning the production?
Question 3: What are your key learning outcomes after the game?
Question 4: Previewing the materials and introduction video for the Manufacturing Sustainability game, what are your initial concerns? What skills and knowledge will you need to succeed in this game?

The group presentation after the Manufacturing Sustainability game (end of week 12 deadline) should include the following questions:
Question 1: How has your team spirit changed from the beginning to the end of the course? Explain how your team worked together.

Question 2: How did the CO2 emissions affect your team's decisions in this game? What were the key differences in your team's strategy between the Manufacturing Sustainability and Manufacturing Introduction games?
Question 3: How did your team handle the data from sales reports, production reports, inventory reports, financial statements, and CO2 emissions reports?
Question 4: What skills and knowledge do you get after playing the games? For example business process understanding, analytical skills, decision-making, or communication skills.
Question 5: How would you want to improve the course?

Fifthly, to address student interest in data analysis and industry expectations for these skills, this study suggests integrating the 'Analytics with ERPsim for SAP S/4HANA' feature offered by ERPSim-Lab. This allows users to access data from the SAP HANA database using data sources designed specifically for ERPSim (see Figure 14). The game data can then be utilized in various courses. Data Analysis course where students can analyze market references from sales reports. Optimization course where data can be used to optimize warehouse capacity and minimize operational carbon footprint. Materials Management course can help students leverage the data for Bills of Materials planning. Furthermore, inviting guest lecturers during debriefing sessions after specific rounds can be highly beneficial. Guest lecturers from the field of data analytics can help students understand how to utilize data effectively and adapt their strategies within the simulation games.

An interview with a Data Analysis and Optimization lecturer (Appendix 4) revealed a strong recommendation for integrating their course with the Logistics Simulation course. The lecturer emphasized that using the same data from different courses can significantly enhance students' skills and knowledge. By equipping students with data analysis skills beforehand, they can immediately apply them to experiments within the simulated business environment. This integrated approach would bridge the gap between theory (data analysis) and practice (logistics simulation), leading to a more effective learning experience and better decision-making with a data-driven mindset for managing virtual companies in the games. Therefore, for optimal effectiveness, it is recommended to offer the Data Analysis and Optimization course either before or concurrently with the Logistics Simulation course.

Solution / Tool	OData	Supported OS
SAP Analytics Cloud	Yes	Windows
SAP Lumira Discovery 2.3	Yes	Windows
SAP Lumira (Previous versions)	Yes	Windows
SAP Predictive Analytics (3.3.9)	Yes	Windows
Microsoft Excel (except Excel 2016)	Yes	Windows
Microsoft PowerBI	Yes	Windows

Figure 14. ERPSim data sources. ERPSimLab.

Lastly, similar to the ERP course, this course could provide students with additional materials for those who want to delve deeper into ERP systems and SAP. This can include resources such as online courses, tutorials, certificates, and industry publications. Leveraging JAMK's membership in SAP University Alliances can further promote student access to learning programs and courses offered by SAP. Additionally, enhancing student learning goes beyond the course content. Exploring the benefits of FiNUG membership can create valuable opportunities for students to connect with companies in the field and be involved in the huge SAP ecosystems. Therefore, inviting guest lecturers on SAP systems can not only provide students with practical insights and motivation but also reinforce the importance of continuous learning, a crucial skill as ERP systems, particularly SAP, are constantly developing.

6.3 Study Reflection

6.3.1 Artificial Intelligence

Nowadays, artificial intelligence (AI) can be a valuable tool in many different aspects of life. Particularly in the study, AI can help to personalize learning by adjusting strengths and weaknesses and supporting languages. It provides instant feedback on the work and provides a range of educational resources, making studying more efficient and effective. Utilizing Gemini, ChatGPT, and Grammarly helped this thesis by providing definitions of some specialized technical terms, brainstorming, grammar checking, and translation.

As this thesis is not a linguistical report, artificial intelligence is allowed to be used as a language assistant and translator. Therefore, AI languages may be detected. Gemini and Grammarly are the most used tools for language matters in this study. Gemini helped to translate technical concepts and refine informal language into a more formal academic tone for the thesis while Grammarly assisted in identifying and correcting grammatical errors, ensuring a polished final report. Although

they might produce incorrect or unoriginal, this thesis responsibly remains the balance of independent thinking and personal languages with AI languages.

Understanding the importance of reliable sources, the information obtained from ChatGPT and Gemini is always verified with reliable and scientifically valid sources. Following best practices and critical thinking, all information obtained from AI tools, including those relevant to specialized technical areas, is meticulously cross-checked with reliable academic sources to prevent plagiarism and ensure factual accuracy.

During the implementation stage, Gemini and ChatGPT helped to formulate a questionnaire based on the learning outcomes of the courses. Besides that, it was used as a personal consultant for finding some relevant solutions. Despite the ready-made answers or solutions from AI, this thesis is responsibly studied with independent thinking, critical thinking, and problem-solving skills. In short, in this thesis, AI was used ethically without any sensitive, confidential, or privacy-compromising information.

6.3.2 Reliability and Ethicality

This study acknowledges the guidance provided by the supervisor and commissioner in navigating the research topic, identifying essential and reliable resources, and ensuring adherence to the ethical guidelines outlined by JAMK. The resources provided by JAMK on research ethics, responsible source usage, plagiarism prevention, copyright, data protection, and research permits were instrumental in establishing a strong foundation for this thesis. As agreed, the commissioner has the right to use this thesis.

The survey and interviews were conducted anonymously, and no personal information was collected. Student interviews were conducted in a classroom at JAMK without any additional parties and recordings. To ensure anonymity and avoid bias, the interviewed students' identities are kept anonymous. Expert interviews were conducted via Teams without other parties and recordings. Interviewing questions were sent to interviewees in advance and informed consent was obtained to utilize the information in the reports.

Material sources from the authored books and journal articles were collected from scientific and reliable sources including Janet Finna, Emerald Insights, Semantic Scholar, Statista, authentic SAP websites, JAMK curricula webpage, and SAP Learning Hub. All unique or not widely known ideas, findings, results, or other information were cited and listed in the reference list according to APA 7th edition style.

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Appendices

Appendix 1. Student survey for ERP-related courses development

ERP-related courses development

This survey supports a bachelor's thesis work, and the aim is to evaluate the effectiveness of the ERP (Enterprise Resource Planning) and Logistics Simulations courses in the Purchasing and Logistics Engineering curriculum and to get objective suggestions on how to improve current ERP-related courses further.

It will take from 3-5 mins to answer all the questions. Please answer all questions honestly to the best of your ability because this survey is anonymous.

dangtrang200111@gmail.com Switch accounts

Not shared

* Denotes required questions

1. Did you take ERP and/or Logistics Simulations course? *

- ERP
- Logistics Simulation
- ERP and Logistics Simulations

ERP - Enterprise Resource Planning

This part aims to understand your confidence level in achieving the learning outcomes for the Enterprise Resource Planning (ERP) course.

2. I am confident that I can identify how ERP helps organizations align operational activities with strategic goals for managing resources and improving efficiency. *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

3. I am confident that I know some well-known ERP systems in the market such as SAP, Oracle, Sage, Microsoft, Infor, etc. *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

4. I am confident that I understand the core technical components of an ERP system such as client/server architecture, user interface, ERP software, analytical layer, and database. *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

5. I am confident that I can identify the key stakeholders (key users, main users, end users, consultants, technical specialists, application specialists, programmers) involved in an ERP implementation and their respective roles. *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

6. I am confident that I can outline the key steps involved in planning an ERP implementation project (system pre-study and comparison, workshops, simulations, conversions, interfaces, training, and so on). *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

7. I am confident that I understand the structure and layout of the Global Bike teaching and learning environments. *

Global Bike is a fictitious bicycle company that is used for SAP environments. Global Bike demonstrates how employees process typical business tasks of a medium-sized manufacturing company in their everyday work environment.

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

8. I am confident that I can apply some basic knowledge and skills in SAP systems after completing some of the case studies such as fulfillment, procurement, production, financial accounting, controlling, human capital management, inventory, warehouse management, v.v into practice. *

	1	2	3	4	5	
Not confident	○	○	○	○	○	Very confident

9. Which aspects of the ERP course can be improved further? *

Please specify or add your own thoughts

- [ ] Content - Basic knowledge
- [ ] Global Bike case studies - SAP environments
- [ ] Less self-study time
- [ ] Go through more case studies together in the classroom along with clear explanation in each step of the case study
- [ ] Test SAP knowledge/skills
- [ ] To provide/suggest more ERP materials
- [ ] Miscellaneous: _____

Logistics Simulations

This part aims to understand your confidence level in achieving the learning outcomes for the Logistics Simulations course.

10. Do you think it is important to take ERP and The World of Logistics before Logistics Simulations? *

Please add your own thoughts if you have any

- ◯ Yes. Both
- ◯ Yes. Only ERP
- ◯ Yes. Only the World of Logistics
- ◯ No
- ◯ Miscellaneous: _____

11. I think it is a great way of playing simulation games in SAP environment (particularly in SAP S/4 HANA) to learn about business strategy and processes. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

12. I have enough knowledge base, instructions and well-explained simulation scenarios to manage my virtual company in simulations games. *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

13. I have learned some critical skills in analyzing business situations and making real-time decisions after playing simulation games. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. I believe that using a real SAP S/4HANA system with actual transactions to evaluate, input, and see the result of my/my team's decisions brings me closer to what an ERP user would experience in the workplace. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

15. I believe that the skills and knowledge I gained after this course are helpful and applicable to my future career. *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. What should be improved in the Logistics Simulations course? *

Please specify or add your own thoughts if you have any

- [ ] Knowledge base/instruction/simulation scenarios
- [ ] Learning environment (ie. via zoom, in the classroom, workshop, etc)
- [ ] To play more rounds of a game
- [ ] To play less rounds but more games
- [ ] To provide more available materials for students who are interested in diving deeper in SAP systems
- [ ] To integrate data analysis skills
- [ ] To organize cross university games
- [ ] To have longer break time among rounds to adjust strategies
- [ ] Course should be taught in the 3rd year instead of 2nd year
- [ ] Miscellaneous: _____

Appendix 2. Student interview questions

Question 1: Could you share your study progress? Which courses have you completed? Have you completed ERP, Logistics Simulation, or both?

Question 2: Could we go through the survey questions? And why did you choose that answer?

Question 3: What kind of challenges have you faced during the courses?

Question 4: How well did you manage to work as a team?

Question 5: What should be improved in the courses?

Question 6: From 1-5, how would you rate your study experiences?

Appendix 3. Expert interview questions

Question 1: Could you please share some backgrounds and experiences with SAP as well as ERP Simulation?

Question 2: How practical do you think those ERP simulation games are?
Question 3: In your opinion, how well did the games prepare students with the skills and knowledge to handle the complexities of managing an organization with an ERP system?
Question 4: How did the simulations promote teamwork and communication skills among the participants?
Question 5: From your experience, are there any areas where the simulations could be improved to enhance their effectiveness?
Question 6: How important is it for students to learn data analysis skills from SAP systems?
Question 7: What are competencies from a business perspective expected from fresh graduate students to deal with ERP systems, particularly SAP?
Question 8: From 1-10, how would you rate the effectiveness of ERPSim in higher education?

Appendix 4. Data Analysis and Optimization Lecturer interview

Firstly, the interview began with an explanation of the Logistics Simulation course content, including a thorough discussion of the Manufacturing Sustainability game.

Secondly, the suggestion of utilizing data from the games was introduced. The pre-set data can be used as a study exercise in the Optimization course to maximize the capacity of the warehouse and to minimize the CO2 emissions. Data obtained from the game can be used for the Data Analysis course to for example analyze the market preferences or competitor product pricing.

Thirdly, the lecturer's thought about the idea was asked. The lecturer's response was enthusiastically positive. He expressed strong agreement that integrating the courses would be highly beneficial for student learning, as using the same data and approaches would enhance their understanding of both subjects. He expressed further interest in collaborating with the Logistics Simulation lecturer to discuss the specifics of course integration.

Finally, the discussion turned to the scheduling of these courses within the purchasing and logistics engineering curricula. The lecturer acknowledged the importance and usefulness of data-driven skills for the simulation games. Therefore, he suggested offering the Data Analysis and Optimization course either before or concurrently with the Logistics Simulation course.

Appendix 5. Commissioner interview

Firstly, the lecturer explained the initial plan for implementing the ERP and Logistics Simulation course. He described that the ERP course was introduced first due to the significant influence of ERP systems and their necessity for student learning. Logistics Simulation was then implemented to provide a practical learning experience with the updated SAP ERP system. Both courses were inspired and developed by the SAP University Competence Center.

Secondly, the interview then turned to the commissioner's expectations for the thesis application. He expressed interest in exploring improvement ideas across various aspects, including course schedules, prerequisite qualifications, learning outcomes, course content, and assignments.

Finally, the discussion focused on the commissioner's willingness to develop the course. Briefly explaining potential solutions, the interviewer gauged the commissioner's receptiveness. He confirmed his openness to all good and feasible ideas.