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Serious Game to Promote Manufacturing as a Service Effect in Resilience of Supply Chain

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Abstract. Supply chain systems are highly vulnerable to disruptions that disturb the flow of goods and materials. Consequently, it is crucial to enhance resilience capabilities within supply chains, enabling networks to restore the performance in the shortest time possible. The concept of supply chain resilience is gaining increasing attention in both research and practice. One promising approach to supporting this resilience is Manufacturing as a Service (MaaS), which allows companies to access distributed products and resources, ensuring the continuity of operations within their supply chains. However, establishing and managing such a dynamic and complex resilience system requires well-trained and skilled personnel. Traditional learning methods, such as books, videos, and project assignments, along with conventional learning environments like classrooms and workshops, are insufficient to fully achieve the desired learning outcomes. This paper explores the use of serious games as a complementary tool to facilitate the acquisition of these outcomes in an environment that blends realistic supply chain elements with playful, engaging features. Specifically, it proposes a systematic approach to defining value dimensions and structuring the reality aspects of serious games, with the aim of increasing the likelihood of successfully achieving the intended learning objectives.

Keywords: Supply Chain Resilience, Manufacturing as a Service, Serious Game.

1 Introduction

Resilience, initially popularized by [1], has been extensively explored across a range of fields and disciplines. While each discipline offers its own definition, they all converge on a central idea: resilience reflects the ability to adapt and react effectively unexpected or unforeseen changes and disruptions [2]. According to [3], resilience can be described as a system's capability to minimize the chances of disruptions, absorb their impact while maintaining performance, and quickly recover or return to normal functioning after disturbances [2].

Covid-19 in 2020, Tohoku earthquake and tsunami in Japan in 2011, the war in Ukraine, and any other natural, man-made (i.e. fire or strike), and financial (financial crisis or bankruptcy) disasters, can cause significant domestic losses and trigger widespread disruptions affecting local and global supply chains. In today's era of globalization, Supply Chain Resilience (SCR) has increasingly emerged as a vital strategy for recovering from supply chain disruptions [4,5].

Resilience closely intersects with supply chain sustainability in various dimensions. As supply chains have become increasingly global, they now form the backbone of the modern economy, exerting direct influence on key sustainability concerns such as employment, natural resource consumption, and more [5]. In that context, supply chain resilience has been defined as one of the fundamental pillars of sustainability [5,6].

On the other hand, with the accelerating pace of global consumption, demand for products and services continues to rise, placing increasing pressure on environmental and societal systems, making sustainability a business imperative in the global marketplace.

In response to growing awareness of the negative consequences of overconsumption, there is a clear shift toward alternative, more responsible models of production and consumption [7]. As a result, concepts such as collaborative consumption and resource sharing are gaining traction across a wide range of industries. The sharing economy is rapidly emerging as a viable alternative to traditional business models, offering more sustainable, efficient, and community-oriented solutions to meet consumer needs. Using platforms and partners to design product-service systems can achieve high sustainability benefits, but producers need to collaborate closely with other actors to fully optimize environmental, economic, and social performance [8]. In that framework, Manufacturing as a service (Maas), enabled by a platform to employ as a sharing manufacturing service, may also lead to a more efficient and sustainable solution, however, the benefits are not guaranteed and the enablers need to be studied.

On the other hand, MaaS enhances supply chain resilience by shifting from rigid physical infrastructures to more flexible and adaptable digital networks, enabling human-centric matchmaking throughout the chain and supporting innovative, responsive business models. However, its impacts on sustainability across the three key dimensions—environmental, social, and economic—remain unclear and warrant further in-depth investigation to fully understand both its potential benefits and unintended consequences.

Serious games have been used to promote understanding of servitisation, however, limited works are presented to actualize the facilitation role of servitisation and MaaS in enhancing resilience in the supply chain. Additionally, [9,10] discusses the lack of serious games in the manufacturing sector especially in practicing non-standard performance measures such as sustainability and resilience. They have emphasized the focus of these games on standard measures, such as accuracy, speed or cost-effectiveness, while the key questions to transition to a more human-centric industry, resiliency and sustainability, are still missing from gamification frameworks.

This study begins by examining the role of serious games as a complementary learning approach for teaching complex and multidisciplinary subjects. Topics such as resilience, sustainability, and supply chain management each involve complicated concepts that are often challenging to convey through conventional methods like lectures, textbooks, or laboratory exercises. Traditional teaching environments frequently fall short of delivering the depth of understanding required to grasp the dynamic interactions among these domains.

In response to these challenges, serious games offer an interactive and immersive alternative. By simulating real-world scenarios, they can facilitate the acquisition of both theoretical knowledge and practical skills within a context that mirrors the complexities of actual supply chain systems. Specifically, a serious game designed to illustrate the implementation of Manufacturing as a Service (MaaS) within a supply chain can help overcome the limitations of traditional training tools. It engages learners through game-based mechanics while promoting deeper understanding through experiential learning.

The objective of this study is to develop a serious game that supports educators and trainees in exploring the value of MaaS in enhancing resilience within supply chains. Through a structured design process

grounded in established game development frameworks, the study seeks to bridge the gap between conceptual learning and real-world application.

2 Background

2.1 Resilience in the supply chain

Nowadays supply chain managers have to manage disruptions almost daily. Disruptions are unexpected events that interrupt the flow of products and materials along the supply chain [11]. Disruptions can be internal to the company, e.g. machine breakdown, or external, e.g. a supplier's failure or a war. Disruptions can be categorized by their likelihood and impact.

To handle these disruptions, organizations and supply chains need to develop what is called Supply Chain Resilience (SCR), which is the ability to "react to unexpected disruption and restore normal supply network operations" [12]. SCR involves: (i) being able to prevent the occurrence of disruptions, (ii) being able to mitigate their impact, while (iii) quickly restoring the supply chain operations [13,14]. Traditionally seen as a static capability, recent studies highlight SCR as enabled by a set of dynamic capabilities that allows supply chains to adapt and withstand disruptive environments [15] (Chari et al., 2024). In fact, the resilience of organisations and supply chains depends on their capabilities, which represent the "ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" [16].

The literature discusses principles and practices for developing SCR capabilities, with various classifications proposed (e.g., [14,16,17]). Key capabilities include flexibility, velocity, visibility, redundancy, collaboration, and awareness & alertness [18]. Flexibility allows for adapting to unexpected events by leveraging other supply chain options, velocity allows for quickly absorbing variations, visibility enables information sharing for quick alignment and disruption prediction, while redundancy involves having extra resources like safety stock or excess capacity. Collaboration supports quick response by leveraging on existing partners and awareness and alertness are the ability to collect data, make sense of them and interpret them in preparation for a new business context [12,16,18]. Each capability is enabled by various practices and levers, thus requiring investments and costs for the companies. For instance, investing in redundancy might mean accumulating stock. The choice of which SCR capability to develop is complex and context-dependent [15].

2.2 MaaS as a promising approach to enhancing resilience

Emerging manufacturing technologies are empowering small and medium-sized enterprises (SMEs) to evolve into cyber manufacturing hubs that offer MaaS by digitizing key elements of the production process—including design, communication, and fabrication [19]. As defined by the MAASive¹ project, Manufacturing as a service (MaaS) is a production paradigm in which resources are offered as services, allowing companies to access distributed manufacturing providers to get quickly on-demand customized products. MaaS can be implemented intra- and inter-company. MaaS requires new relationships between providers and users of the service, based on flexible contracts. In addition to manufacturing, the services offered can be logistics and design. Customers can participate in the design of the product. MaaS can be facilitated by technological solutions (platforms) that allow the sharing of information about resources, the

¹ European Union (MAASive Project, Grant agreement ID: 101138040)

matching between demand and supply of services and the sharing of data between partners. In this definition, the term resources refer not only to machines but also software, HR and data.

The transition in the manufacturing landscape is driving a new paradigm whereby employing MaaS, large manufacturers and original equipment producers can delegate component production to a network of decentralized SMEs situated closer to the end-use location [19,20]. In addition to that, MaaS has enabled a shift from an integrated production system to a more open one. This shift makes the supply chains more adaptable, more robust and more flexible. Additionally, this new paradigm is capable of scaling production capacities and customer [21]. Consequently, supply chains are transforming into fully integrated digital threads, which helps reduce the burden of dependency on traditionally physical supply chains and eases resiliency of the system [20].

MaaS environments significantly impact supply chain efficiency by prioritizing human decision-making in managing supply and demand. This human-centred approach ensures that MaaS systems are not only technologically sophisticated but also flexible and responsive to human needs and preferences. By incorporating semantic matchmaking techniques, decision-makers can more effectively synchronize supplier services with demand for physical goods, including logistics and warehousing. This results in improved strategic planning, more resilient operations, and enhanced overall supply chain resilience [22].

The adoption of advanced technologies, such as additive manufacturing and blockchain, is reshaping Manufacturing-as-a-Service (MaaS) by driving greater efficiency, resilience, and security across supply chains. The emergence of digital MaaS ecosystems is revolutionizing global manufacturing by streamlining data exchange, enabling new business models, and fostering a more interconnected production network. By integrating technologies like digital twins and smart factory webs, these ecosystems enhance supply chain flexibility and sustainability, ensuring that production processes remain adaptive to market dynamics [21,23]. Furthermore, the ability to remotely access and control manufacturing resources transforms operational agility, fostering continuous innovation and scalability. This shift is particularly impactful for small and medium-sized enterprises (SMEs), as it reduces barriers to entry, enhances their capacity to respond to fluctuating demand, and strengthens overall resilience in an increasingly digital and competitive landscape [24,25].

The MaaS model drives innovation by enabling agile, market-responsive business models that enhance adaptability and competitiveness. By integrating blockchain and cloud manufacturing systems, MaaS fosters collaborative, transparent, and sustainable supply chains, particularly in industries like transport manufacturing, where efficiency and coordination are critical [7]. Moreover, MaaS platforms optimize pricing strategies, striking a balance between profit maximization and supplier engagement, ensuring long-term business sustainability [8]. This data-driven approach to resource allocation and cost management strengthens resilience, reduces operational risks, and enhances the overall stability of the supply chain, positioning MaaS as a key driver of future-ready, dynamic manufacturing ecosystems.

2.3 Serious games: a popular method for training in supply chain

As supply chain management continues to evolve, educational and training methods must also advance to effectively engage learners and prepare them for the complexities and dynamic nature of modern supply chains [26]. One promising approach is the use of serious games, which create interactive, challenging, and immersive environments that allow players to assume various roles within a supply chain. By blending learning objectives with simulated supply chain scenarios and incorporating elements of play, serious games have garnered significant attention from educators and trainees alike. This unique balance supports higher levels of learning, as described in Bloom's taxonomy [27].

Over the past decades, a growing body of research has explored the design and application of serious games as a complementary method to traditional training in supply chain management [26,28,29]. [26], for instance, reported on the benefits of the "Supply Chain Lingo 101" game in fostering strategic thinking in logistics and supply chain operations. The game provided learners with opportunities to practice critical SCM concepts such as problem-solving, decision-making, and teamwork. Similarly, [30] examined a supply chain game delivered in both card and board game formats within an academic setting, highlighting its integration into supply chain management curricula.

[31] underlined the limitation of conventional instruction methods in bringing the various real practices of supply chain management into the classroom setting. To close this gap, they developed and used Dragon games including five levels and took almost the whole semester at 11 weeks. The story of the game challenges players to make sustainable business decisions that would have financial, social, and environmental impacts on other players representing other stakeholders in a supply chain network.

Recent research has also investigated the use of serious games in topics closely related to supply chain management, such as circular economy. Given the growing emphasis on optimizing resource use and minimizing waste throughout the product lifecycle, the integration of circular economy principles into supply chain management has become an essential variable. [32] noted the challenges of teaching these multidisciplinary concepts in classroom settings. To address this, the "Risk & RACE" game was developed to teach circular strategies at the business level. Participants, including students and entrepreneurs, demonstrated an improved understanding of how circular strategies function under external resource constraints. The game design, which offered players the autonomy to select strategies and navigate limitations embedded in the game narrative, fostered both team collaboration and inter-team competition.

In recent years, several studies have explored how serious games can enhance understanding of servitization and help address barriers to its implementation [33,34]. A systematic literature review by [35] identified key gamification features relevant to servitization contexts, suggesting that serious games are well-suited for advanced service sectors such as supply chains. [36] emphasized that, due to the broad knowledge base required for servitization, serious games can be more effective than simulations alone in engaging stakeholders in manufacturing systems. They developed a Snakes and Ladders-inspired game that encouraged players to navigate the enablers and barriers of servitization.

Building on this work, [33] highlighted the capacity of serious games to demonstrate servitization benefits, facilitate stakeholder understanding of transformation processes, and support critical reflection. [34] further investigated the emotional mechanics embedded in games and how they help overcome challenges in adopting servitization. Their findings culminated in six propositions for using emotional game mechanics to support providers and users in the transition to advanced service models.

Despite the growing interest in using serious games to promote understanding of supply chain management and servitization, limited research has addressed their role in facilitating the actual implementation of servitization for increasing the resilience of supply chain systems. One notable exception is a study by [37], which examined gamification's role in the servitization of green supply chain management practices. Data collected from 254 companies revealed that gamification positively moderates the relationship between digital servitization and supply chain performance.

3 Methodology

3.1 The Triadic model for game design

Designing serious games is inherently complex, as it involves delivering knowledge and developing skills within a playful, yet realistic, simulated environment. The success of a serious game strongly depends on the thoughtful integration of its three core elements: learning, realism, and entertainment [38,39]. To ensure this balance, scholars advocate for a systematic design approach that minimizes the risk of disproportion among these essential components.

[40] approached serious game design from a stakeholder-centered perspective, identifying key stakeholders and proposing a system that supports their varied interests and value preferences. While this framework presents a novel strategy to enhance the design process, there is limited empirical evidence regarding its practical application.

The Four-Dimensional Framework (FDF) developed by [41] has been widely used across various domains to guide the development of serious games. Despite its popularity, we opted not to adopt this framework for our game design due to two primary limitations. First, FDF emphasizes balancing the four components—context, pedagogy, learner, and representation—which are more aligned with learning objectives and do not sufficiently address realism and entertainment. Second, our literature review revealed no documented use of the FDF in the design of serious games specifically for supply chain management or Manufacturing-as-a-Service.

In contrast, the Triadic Game Design (TGD) model proposed by [38] offers distinct advantages by equally emphasizing three fundamental pillars: Meaning (learning outcomes), Reality (authenticity of the scenario), and Play (engagement and fun). This model ensures that games not only reflect real-world systems and processes relevant to supply chain challenges but also meet learning goals in an engaging manner. [42] aptly described the role of a game designer under TGD as akin to a juggler, skillfully keeping three balls—representing meaning, reality, and play—in motion, with equal and continuous attention to each.

[43] examined various serious game design models to identify a suitable approach for developing a game aimed at exploring supply chain optimization. They highlighted that much of the existing literature treats game design as a standalone object, with limited emphasis on adopting a systematic design methodology. Among the few studies applying such an approach, [44] stood out for utilizing the Triadic Game Design (TGD) model in the context of a fire safety evacuation game.

More recently, [45] applied the TGD model to develop a serious game intended for research in project management. Their study demonstrated the model's value in providing a structured, effective method for collecting and analyzing data related to stakeholder performance within project environments. However, the specifics regarding how the elements of meaning, reality, and play were developed and how they interacted remain underexplored in their work.

3.2 The game design process

Given the primary goal of this study—to design a serious game promoting Manufacturing-as-a-Service (MaaS) within resilient supply chains—selecting a design approach that simplifies complex real-world elements while maintaining alignment with learning objectives and playability is essential. The TGD model is particularly well-suited for this purpose (see Figure 1). Its structured methodology enables the development of games that simulate supply chain disruptions (e.g., supplier failures, market volatility, and geopolitical risks) with high fidelity (reality), reinforce learning objectives such as leveraging MaaS to

mitigate risk and applying resilience metrics (meaning), and integrate engaging mechanics that motivate continued participation (play).

The next two sections detail the development processes for the "Meaning" and "Reality" components used in designing the MaaS in SCR serious games.

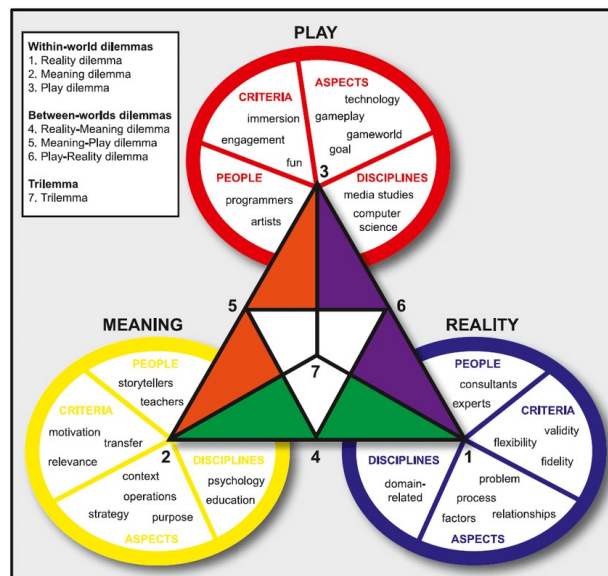


Figure 1. Traidic Game Design (TGD) model [38]

Meaning: [38] outlines a structured approach for organizing the “Meaning” dimension of serious games, aimed at supporting stakeholders such as educators, teachers, trainers, and psychologists. The process begins by identifying the core value the game is intended to deliver to its players. This is followed by formulating a clear purpose and breaking it down into specific, measurable learning objectives. To realize these objectives effectively, a well-defined strategy is required, which is then translated into concrete game mechanics—actions within the game that align with the overarching learning goals.

To apply this framework in designing the “MaaS in Supply Chain Resilience” (MaaS-SCR) game, we transformed Hartevelde’s guidelines into a structured worksheet. This tool was used during an expert workshop with four faculty members from the fields of industrial and management engineering. Participants responded to a series of adapted questions, providing essential input to define the game's value, purpose, strategy, operations, and context.

The preliminary “Meaning” document was then validated in a follow-up workshop attended by 18 participants from the MAASive project consortium, including representatives from Aalborg University (Denmark), Ecole Centrale de Nantes (France), Politecnico di Milano (Italy), and Technische Universität Hamburg (Germany).

Reality: to guide the development of the “Reality” component—the authentic context in which the game unfolds— [38] also proposes a stepwise method. It begins by articulating both the current state (“as-is”) and the desired state players aim to achieve within the game. This forms the foundational problem statement, around which the game challenges are designed.

Next, the relevant factors contributing to these challenges are identified. Mapping the interrelations between these factors yields a static model of the game environment. To enhance realism, this is further extended into a dynamic model that captures how these variables interact and evolve—providing insight into the timing, causes, and consequences of events within the game.

To gather the information necessary to define the “Reality” dimension of the MaaS-SCR game, a dedicated workshop was organized with ten experienced managers and engineers. This session was part of the MAASive project consortium meeting held in March 2025 in Hamburg. At the outset, a facilitator introduced the workshop objectives, provided an overview of the Triadic Game Design (TGD) model being used in the game development process, and presented the documented results from the “Meaning” phase.

Following this introduction, participants from each represented company were asked to contribute insights by completing a worksheet designed to capture key components of the “Reality” aspect, including the central problem, contributing both critical and environmental factors, and the relationships among those factors. Figure 2 shows participants working on the definition of the “Reality” features. Consent for the use and publication of this photo was obtained from all individuals depicted.



Figure 2. Expert Workshop for Defining the Reality Aspect of the MaaS-SCR Game

4 Results

The outcomes of the Meaning workshop session were structured around key elements that help integrate learning objectives into the serious game design process. The central learning goal identified was to demonstrate how Manufacturing as a Service (MaaS) can enhance resilience in manufacturing systems during supply chain disruptions. This objective reflects the collective concerns of the experts involved, addressing three interconnected themes: MaaS, supply chain resilience, and sustainability.

Additionally, the workshop participants emphasized that the game should go beyond conveying theoretical knowledge—such as distinguishing between static and dynamic resilience capabilities—and also support the development of practical and analytical skills. For example, players should be able to assess the impact of MaaS adoption on sustainability-related performance indicators.

To achieve this goal, experts shared insights from previous successful games and related learning tools, recommending mechanics that effectively convey value and purpose. A scenario-based learning approach was proposed, allowing players to explore situations both with and without MaaS integration. This contrast would help highlight the strategic advantages of MaaS in managing disruptions.

To operationalize this strategy into tangible game mechanics, a round-based structure was suggested. In the initial rounds, players would navigate typical supply chain operations under stable conditions. In subsequent rounds, they would face unexpected disruptions, initially manageable through conventional resilience tools. In the final rounds, players would be challenged with complex disruptions that can only be resolved through the adoption of MaaS strategies. This progression is designed to guide players toward a deeper understanding of MaaS as a critical enabler of supply chain resilience. A summary of the workshop's results is presented in Table 1.

The outcomes of the Reality workshop provided valuable insights into the context in which the game's story unfolds. One key theme emphasized during the session was the need to develop a structured framework of situations through which players progress toward achieving a desired state. Each participating team, drawing on its industry expertise, proposed a specific scenario. For example, a team composed of members from a household appliance company described a situation where the gasket production line for refrigerators was disrupted due to the unavailability of "thermoplastic elastomers" from suppliers. They detailed the key elements necessary for transitioning from this problematic situation back to normal operations.

These findings offer important guidance for game designers on how to create characters, artifacts, and phenomena that realistically represent the challenges players must address. Furthermore, the workshop discussions underscored the importance of accurately reflecting the interactions among factors within the game environment. While participants agreed that illustrating complex relationships could enhance players' understanding of the problem, they also recognized that excessive complexity might overwhelm players, discourage engagement, and ultimately hinder the achievement of learning objectives.

Table 1. A summary of the meaning document

Item	Description
Value	<ul style="list-style-type: none"> • MaaS increases the resilience during supply chain disruptions
Purpose	<ul style="list-style-type: none"> • Understand how MaaS facilitates market demand response during supply chain disruptions. • Analyze the impact of MaaS on sustainability • Understand the concept of supply chain resilience and the capabilities/tools/levers required to build it. • Understand how to select supply chain resilience capabilities to mitigate the impact of disruptions on economic, environmental and social sustainability outcomes • Develop skills such as teamwork and time management to navigate complex decision-making under uncertainty.
Strategy	<ul style="list-style-type: none"> • Simulate a simplified real-world case study on the role of MaaS in supply chain resilience. • Implement a scenario-based learning approach where disasters disrupt traditional supply chains, prompting players to adopt MaaS solutions. • Present trade-offs between cost, environmental and social sustainability, and lead time to foster critical thinking.

Operations	<ul style="list-style-type: none"> • Teams manage manufacturing companies that face various events disrupting the supply chain. • Teams can choose between in-house production, outsourcing to a MaaS provider, or adopting a hybrid approach. • Frequent feedback, such as scoring at the end of each round, highlights the impact of decisions on team performance. • Challenge teams to balance conflicting values and make trade-offs to meet market demand as effectively as possible.
Context	<ul style="list-style-type: none"> • Target Audience: <ul style="list-style-type: none"> ○ Industrial engineering and Management engineering students ○ Trainees learning about MaaS • Deployment: <ul style="list-style-type: none"> ○ University course ○ Corporate training programs • Supporting: <ul style="list-style-type: none"> ○ Facilitators leading briefing – game – debriefing sessions

5 Conclusion

Supply Chain Resilience (SCR) has become a widely recognized strategy for enabling supply chain systems to withstand and adapt to various disruptions that interrupt the flow of goods and materials. In recent years, SCR has received growing attention due to the increasing frequency and severity of both internal and external disturbances affecting supply chain operations. However, traditional SCR capabilities are no longer sufficient on their own to effectively manage and mitigate the impacts of such disruptions. As a result, numerous studies have emphasized the need to adopt new dynamic capabilities that enhance the adaptability and responsiveness of supply chain systems, enabling them to better absorb shocks and recover more rapidly in the face of ongoing challenges.

Empirical, experimental, and quantitative modeling efforts in the fields of supply chain resilience and sustainability have traditionally been pursued independently, with only limited research exploring the interconnections between the two. However, studies have shown that sustainability can be a critical aspect and a fundamental of resilience in supply chain by employing efficient structural reconfigurations in response to disruptions considering their environmental, economic and societal/political impacts.

Manufacturing-as-a-Service (MaaS) has emerged as a promising approach for enhancing the resilience of supply chain management. By leveraging digital platforms to offer manufacturing products and resources as services, MaaS enables companies to access distributed assets and capabilities, facilitating rapid responses to unexpected disruptions within their supply chains. In addition to improving flexibility and responsiveness, MaaS also supports more efficient supply and demand management. Its emphasis on empowering human decision-making positions it as a human-centred approach, aligning operational agility with strategic oversight. Altogether, by sharing manufacturing service, optimizing resource use and improving the measurement and communication of sustainability performances through digital platforms, MaaS can support and enable sustainability in the supply network.

The complexity of Supply Chain Resilience (SCR) requires professionals who are not only well-versed in theoretical knowledge but also equipped with practical skills to design, implement, and manage resilient supply chain systems. However, the inherently multidisciplinary nature of SCR presents considerable challenges for traditional educational methods. Conventional teaching approaches often lack the

experiential context needed to effectively bridge theory and practice—especially when it comes to preparing learners to handle real-world supply chain disruptions and uncertainties.

To address this gap, this article first emphasizes the effectiveness of serious games as a recognized method for imparting supply chain resilience (SCR) knowledge and skills across varying levels of complexity. While numerous studies have explored the use of games in supply chain management, few have focused specifically on serious games that simulate the dynamic capabilities required for resilience in supply chains. In response, this article adopts the Triadic Game Design (TGD) model—a validated and systematic framework—to guide the development of the MaaS-SCR game. Within the TGD model, the meaning dimension was used to define and structure the game’s intended learning outcomes, ensuring they are specific and measurable. Additionally, a preliminary workshop involving experts in the field was conducted to identify key aspects of real-world supply chain environments frequently affected by disruptions, which are essential to be reflected in the game design.

In a nutshell, the MaaS-SCR game is designed to deepen players’ understanding of supply chain resilience by enabling them to explore both static and dynamic capabilities during strategic decision-making. Through gameplay, participants uncover the substantial benefits of Manufacturing-as-a-Service (MaaS) functionalities as effective enablers for managing diverse disruptions across the supply chain. Additionally, the game challenges players to make decisions that balance conflicting sustainability dimensions—economic performance, environmental responsibility, and social impact. In future developments, the game will be further enriched with playful elements to increase player engagement and facilitate deeper immersion in scenario-based decision-making.

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