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Abstract

Firms have started to run innovative campaigns to help achieve sustainable green supply chain practices. The concept of 'servitization' – where firms develop new value propositions by transitioning from product manufacture to provision of integrated solutions incorporating products, functions, and services – has attracted considerable attention from the academic community. Recent studies have shown that not all forms of innovation (for example, disruptive, incremental, sustaining, and radical) are practiced by firms to ensure GSCM. The choice of innovative practices is often sustainable and is thus short-lived. Furthermore, there are gaps in intertwining the four dimensions: GSCM, innovation, sustainability, and servitization. We propose "Gamification" as a thread that binds the four dimensions together. We propose "gamification" as an innovation in the firms to contribute to sustainable green supply chain management in a servitized ecosystem. The study proposes to collect data from retail sector firms using a structured questionnaire. The study will collect responses from 254 respondents to answer the research question. The theoretical model will be tested using Warp PLS 7.0. The results would contribute to the literature on servitized innovation practices in firms using gamification. The study also proposes to open doors for firms to revisit new and innovative gamified ways to contribute to long-term and sustainable green supply chain management.

Keywords: Servitization; Green Supply chain management; Gamification; Sustainability; Innovation

1. Introduction

United Nations (UN) has outlined seventeen sustainable development goals (SDGs) focusing on economic, environmental, and social dimensions. Moreover, customers, governments, and non-governmental organizations also call for sustainable development. Due to pressure from all stakeholders, Firms across the globe have changed their strategies and started adopting sustainable business practices. Apart from economic performance, measuring environmental and social performances has become crucial. Sustainable performance combines economic,

environmental, and social performances (Chardine-Baumann & Botta-Genoulaz, 2014). Therefore, the firms must adopt best practices across the supply chain to perform on all three dimensions. One of the best practices is green supply chain management (GSCM) practices that focus on sustainable performance.

Initially, GSCM practices focused more on economic and environmental dimensions, but social responsibility has picked up in the past 15 years (Mitra & Datta, 2014). In several countries, it is mandatory to publish corporate social responsibility (CSR) reports by the firms. Moreover, a few standards (for instance, ISO 26000) of international organizations for standardization emphasize social responsibility. Previous studies have shown that firms that adopt GSCM practices gain a competitive advantage and perform sustainably (Kamble et al., 2019; Niesten et al., 2017). The other facet to attaining sustainable performance is through setting up clear goals. Goal setting theory (GST) suggests that placing clear, measurable, and challenging goals leads to better performance (Locke & Latham, 2002). Although GST was developed for employee motivation, it has been used widely in the supply chain context (Min & Zhou, 2002; Wong et al., 2012). Haavisto & Goentzel, (2015) have shown that GST improves supply chain performance. In this study, we propose that firms that set clear and measurable goals to achieve sustainable performance will have better chances of succeeding.

Digital servitization (DS) is one of the ways to adopt GSCM practices and achieve goals successfully. DS is defined as digitally offering services coupled with products (Coreynen et al., 2017). With the advent of digital technologies, such as 3D printing, artificial intelligence, and blockchain, firms use them for customization, standardization, and product innovation (Harrmann et al., 2022). With DS, the firms can reduce energy consumption and lead times and implement environmentally friendly processes (Baines & Lightfoot, 2014; Schiavone et al., 2022). In addition, the firms can shift to new paradigms, such as the circular economy and reverse logistics with DS. The literature indicates that DS can play a considerable role in a firm's efforts to fulfil its commitment (Coreynen et al., 2017). Furthermore, setting up goals for the firms becomes more manageable if they have the adequate digital infrastructure (Fichman et al., 2014). We believe, in this study, that DS impacts (indirectly, if not directly) the sustainable performance of the firm.

The extant literature suggests links between GSCM-sustainable performance, DS-GSCM, and goal commitment & performance (DeShon et al., 2004; Opazo-Basáez et al., 2018; Terzi et al., 2023). However, to the best of our knowledge, none of the studies has studied them together.

Therefore, in this study, we integrated all these concepts to build a research model to fill this gap. More specifically, we want to study the direct effects of GSCM and goal commitment on sustainable performance. Additionally, we want to examine the relationship between DS and sustainable performance through GSCM practices and goal commitment.

Next, gamification has gained attention in the recent past by both academicians and practitioners (Warmelink et al., 2020). Gamification is defined as creating and designing gaming experiences in a real-world setting to engage and motivate employees. The outcome of gamification is to improve organizational performance. The literature on gamification indicates that introducing gameful experiences in the supply chain (for example, production, logistics, and warehousing, among others) increases productivity, engagement, and performance. Furthermore, gamification helps set up and update goals in the supply chain context. The literature also indicates that gameful experience enables sustainability and green behaviour (Paravizo et al., 2018). Therefore, we believe a gameful experience may enhance the relationship strength between DS-goal commitment and DS-GSCM practices.

The current study draws theoretical support from self-determination theory (SDT) and goal-setting theory (GST). First, the SDT identifies the needs for optimal functioning of growth, social development, and personal well-being (Deci and Ryan, 1985). The identified needs are autonomy, competence, and relatedness. In the current study context, we believe that when competent employees are given autonomy and relatedness to the organization, they are likely to develop innovative practices that will improve overall performance. Next, the GST refers to setting clear and measurable goals that will motivate employees to achieve those goals (Locke & Latham, 2002). In the current study, we propose that setting up goals for the firm and the entire supply chain will improve performance and increase the supply chain visibility. When each actor in the supply chain is aware of the Goal, they will work towards achieving that and improve the overall supply chain performance.

The remainder of the paper is structured as follows: Section 2 presents the theoretical background and literature review. Hypotheses of the study are developed in Section 3. Section 4 outlines the development of the survey instrument, sampling design, and data collection. Data analysis and results of the study are presented in Section 5. Section 6 offers a discussion of the results. Finally, future research opportunities are discussed in the last Section.

2. Theoretical Background

This study examines the role of gamification in servitized green supply chain management (GSCM) practices to attain sustainability. To do so, we adopted the theoretical framework of self-determination theory (SDT) and goal-setting theory. The subsequent sub-sections justify the applicability of these theories to build the conceptual model and gamification in supply chain management (SCM) (Bahr et al., 2022; Warmelink et al., 2020).

2.1 Self-Determination Theory

A motivational theory, Self-Determination Theory (SDT), focuses on how people's fundamental psychological desires for competence, autonomy, and relatedness affect their behaviour (Deci & Ryan, 1985). SDT has been applied in supply chain operations to understand and improve employee motivation and engagement to carry out supply chain management practices (Behl et al., 2022a). SDT posits that employees in supply chain management are most likely to be motivated, engaged and perform better in their tasks when a) they feel that they have autonomy over their actions (e.g., control over their work process and decision-making), b) that they can effectively and competently navigate their environment (e.g. perform their tasks effectively) and c) that their actions are related to the organization (e.g. aligned with the company's mission and values) (Roehrich et al., 2017). These employees are likely to develop creative solutions to problems, take innovative initiatives and be more committed to their work leading to improved productivity and efficiency that is more likely to advance the overall supply chain operational performance.

2.2 Goal-Setting Theory

A psychological theory, Goal-Setting theory, contends that well-defined and challenging goals improve employees' task performance and motivation (Locke & Latham, 2002). The theory suggests that when others set clear, measurable, and challenging goals, they can help employees focus their efforts, increase their persistence, and achieve better results (Locke & Latham, 2006). Employees are motivated to perform better when provided with challenging, difficult goals. This is explained by the linear link between performance motivation and goal difficulty (Latham & Wexley, 1993; Locke, 1968). Goal-setting theory in the supply chains can help set specific and challenging goals about managing inventory levels, improved delivery times, and cost savings leading to overall sustained performance. Similarly, setting up a plan to improve delivery times can enhance supplier relationships and customer satisfaction. Goal-setting theory clarifies the connection between goal-setting and strategic management, resulting in improved supply chain performance (Haavisto & Goentzel, 2015).

2.3 Gamification in supply chain management

Gamification has myriad uses in supply chain management at the operational, tactical, and strategic levels (Tomé Klock et al., 2021). It enables various functions in the SCM (viz., logistics and production (Warmelink et al., 2020); order picking, warehousing, and sustainable manufacturing (Tayal et al., 2022)) which improves engagement, motivational experiences, and compliance to regulations (Huotari & Hamari, 2017). Supply chain practices incorporate game design such as awarding points, embedded stories, clear goals, feedback, progress, and rewards to encourage energy-efficient and safe driving (Klemke et al., 2014), plan and execute operational interventions, and coordinate humanitarian logistics, thereby, enhancing day-to-day activities (Shang & Tseng, 2010). Logistics and on-floor activities are usually mundane and repetitive. Incorporating game design elements can help elevate employee motivation, enable skill development and faster learning, improve competition and productivity and improve performance tracking. Furthermore, it can promote increased employee morale, easier performance tracking and better feedback. Warehousing tasks, such as order picking, quality control, training, crane driving, and truck loading, are traditionally labour-intensive, mundane, monotonous, costly, or demanding (Bahr et al., 2022). Warehouse managers are now incorporating game elements to improve motivation and performance, eradicate warehousing costs, reduce waste, and increase efficiency (Putz et al., 2019). Gamified elements can be used for logistic employee training and education purpose (Teras et al., 2016; Wanick & Bui, 2019). While there are tremendous promises of using gamification in supply chains, certain obstacles of strict budget limitations, intensive resource allocation and sustainability of gamification may impede the total usage over long-time periods (Bahr et al., 2022).

2.4 Supply chain management and Servitization

'Servitization' (Lightfoot et al., 2013) is the change in an organization's business model where they transition from selling products to selling services offering improved value to customers (e.g., maintenance, repair, operations services, product upgrades, subscriptions, and value-added services) (Baines et al., 2017). Despite having outstanding technical and product-focused capabilities, manufacturing firms lack resources and competencies needed to offer the goods and services (Xing et al., 2017). Incorporating this new strategy can require the organization to develop new capabilities, exhibit better inter-firm relations or outsource certain activities within the supply chain (Kreye et al., 2015), which requires top management commitment, strong leadership, service and manufacturing capabilities (Shah et al., 2020). Servitization

affects supply chain management as companies need to rethink their entire supply chain to support the delivery of services and meet customer expectations. This may include changes in procurement (e.g. securing a reliable supply of parts to support the service offering), inventory management (e.g. holding a sufficient level of delivery to support service delivery), logistics (e.g. timely delivery of parts and components for repair and maintenance), service delivery (e.g. efficient and effective delivery to ensure customer satisfaction), collaboration (e.g. work together with different supply-chain partners) and technology (e.g. use digitized and integrated technology like cloud, IoT for service delivery).

3. Hypothesis development

3.1 Digital Servitization and Goal Commitment

Digital servitization allows manufacturers to realize revenue and profitability goals (Bandinelli & Gamberi, 2012). In some instances, additional services offered by manufacturers can increase revenues by 20% to 35% to up to 50 % of revenues (Wagstaff et al., 2021). Servitization can help improve competitive advantage, as rival suppliers may find it challenging to replicate the offerings. Digital servitization minimizes risks and uncertainties, making maintenance and support expenses predictable from a customer's standpoint while increasing sales revenues from a supplier's point of view (Slack, 2005). With servitization, organizations can align their goals with those of the customers, leading to improved engagement through regular interactions and collaborations, increased commitment to achieving goals, and fostering long-term relationships with customers over the years. These measures enable both parties to accomplish their goals leading to a successful relationship. Companies can strengthen goal commitment through collaboration and shared responsibility for achieving common goals by working closely with customers and supply chain partners (Ziaee Bigdeli et al., 2021). Based on the above discussion, we propose,

H1: Digital servitization is positively associated with goal commitment

3.2 Digital Servitization and Green Supply chain Practices

Digital servitization transforms the traditional product-based organization into one that provides online services (Andrews et al., 2018; Baines et al., 2017; Vendrell-Herrero et al., 2017). To achieve this, organizations incorporate digital capabilities such as data analytics, blockchain technology, artificial intelligence (AI) and Internet-of-Things (IoT) into products and services to enhance their value and functionality (Abou-Foul et al., 2023; Kohtamäki et al.,

2019; Paschou et al., 2020). The difference between product-based organizations and digital service-focused organizations is that the former focuses on manufacturing and selling goods. In contrast, the latter focuses on creating new revenue streams by offering digital streams to enhance the goods' value and improve customer engagement (Chirumalla et al., 2023). Digital technologies can optimize and reduce supply chain operations' inefficiencies, reducing waste and harmful impact caused (Ivanov et al., 2019). Organizations can use digital technologies to trace and monitor their supply chain partners' sustainability impacts, track their suppliers' environmental impact, or automate logistic procedures to save resources (Saberi et al., 2019). Digitized services lend themselves to developing new sustainable products wherein customers are aware of the real environmental effect of their actions. Digital services can further augment green supply chain practices by introducing virtual meetings and cutting physical transportation costs. Furthermore, with digital servitization, employees in the organization can monitor and optimize the performance of their equipment in real-time and provide customers with personalized and responsive services. With the above discussion, we examine,

H2: Digital servitization is positively associated with green supply chain practices

3.3 Goal Commitment and Sustainable Performance

According to the goal-setting theory, there are five elements of goal-driven performance: goal commitment, goal importance, individual tactics, task complexity, feedback and self-efficacy (Locke & Latham, 2002). The most vital component here is goal commitment which is significantly influenced by goal importance. Organizations that are dedicated to attaining their objectives put forth ongoing efforts to achieve sustainable performance. They collaborate more effectively and align their efforts to accomplish customer focus. Organizations can align their goals with customer needs by focusing on providing value-added services, thereby improving satisfaction and performance. They build long-term relationships with customers through servitization to create a sustainable source of revenue, leading to sustainable performance. Servitization leads to improved products due to continuous improvement as companies strive to improve their offerings to meet the changing customer needs. To accomplish this, companies must adapt to market conditions and focus on providing offerings in response to customer needs to achieve sustainable performance. Past literature suggests that an organization's commitment towards servitization has been responsible for improved financial performance (Benedettini et al., 2017; Rapaccini & Visintin, 2015). Thus, based on the above discussion, we postulate,

H3: Goal commitment is positively associated with sustainable performance

3.4 Green Supply Chain practices and Sustainable Performance

Green supply chain management (GSCM) comprises several external and internal and external supply chain practices, including green purchasing, green manufacturing, distribution, packaging, and marketing (Yildiz Çankaya & Sezen, 2019). Green initiatives can help organizations reduce waste and emissions by using renewable energy sources, and promoting recycling and conservation, thus improving the overall supply chain impact (e.g., environmental, social and economic performance) (Zaid et al., 2018). The rigorous environmental regulations, public perception and scrutiny and achieving a competitive edge are compelling organizations to reduce environmental risks and consequences while enhancing ecological efficiency (Ambec & Lanoie, 2008). Implementing green practices within the supply chain leads to cost savings and an enhanced reputation that contributes to the organization's long-term financial success assisting enterprises and their partners in achieving profit and market-share objectives (Azevedo et al., 2011). Numerous studies have suggested the effectiveness, efficiency and scope of GSCM activities determine the impact they have on environmental performance, such as saving energy, reducing emissions, waste and pollution (Geng et al., 2017; Rehman Khan & Yu, 2021), economic performance such as growth in profit, sales and market share (Schmidt et al., 2017; Younis et al., 2016) and operational performance such as decreased scrap rates, better inventory management, on-time delivery and capacity utilization (Balasubramanian & Shukla, 2017; Zhu et al., 2012). These activities give the organization a comprehensive and long-term advantage of green supply-chain practices, making it possible to justify long-term investment decisions. E.g. when a firm invests in GSCM practices, it gains a competitive advantage, such as a better brand reputation, which leads to increased sales and marketing share. These organizations can either expand in new markets or have a competitive edge towards their non-adopting rivals. The gains accrued by practicing green initiatives can help organizations recover their investments, thus improving return on investment (ROI) and improved profits (Habib et al., 2022). To facilitate sustainable supply chain performance, a summation of economic, performance, environmental and social factors must me achieved (Geng et al., 2017). Based on the above discussion we propose,

H4: Green supply chain (GSC) practices are positively associated with sustainable Performance

3.5 The moderating role of Gameful Experience

Gameful Experience (GE) in supply chain activities creates game-like systems to support positive Experience (Tomé Klock et al., 2021; Winkelhaus & Grosse, 2020), which can be combined to create a powerful mechanism to motivate and improve supply chain performance. Supply chain practices lend themselves to a myriad of tasks that can utilize gamification (e.g., production and process engineering, production planning (Korn & Schmidt, 2015; Neto et al., 2014), operational tasks on the factory floor, warehousing tasks, production execution, supply chain design and planning, transportation planning and execution (Hense et al., 2014)) for improving individual behaviour and improved organizational Performance (Huotari & Hamari, 2017). Gamification essentials such as reward points, leader boards, and badges can be extensively used in business environment practices to foster better engagement and motivation to create a sense of competition and progress (Pereira et al., 2022). Goal commitment in supply chains is accentuated when combined with gamification elements as it makes the goals more visible and tangible, making it easy to track progress and engage more towards continuing to work towards committing to their goals and making progress. For example, a leaderboard that displays the figures of different team members achieving their goals can encourage individuals to work towards meeting those goals. The same may be aid about using gamification reward points, badges, challenges, and leaderards to recognize and honour individuals or teams that have surpassed to meet their goals. GE can encourage incorporating green supply chain practices in imparting digital services to achieve sustainable goals. Organizations can create games incorporating environmental considerations into the design or simulation to educate employees about the hostile effects of their activities on the environment and adopt sustainable behaviour in their routine tasks. The act of rewarding employees for using green supply chain practices in digital services for completing timely orders, responding to customer queries virtually, and using digital payment methods can lead to a shift towards digital servitization. With the above discussion we propose,

H5a: Gameful Experience moderates the role of digital servitization and goal commitment

H5b: Gameful Experience moderates the role of digital servitization and green supply chain management (GSCM) practices

3.6 Control Variables

In this research, we have controlled the confounding effect of firm size and firm age. Firm size helps to determine whether the firms have the motivation, skills, resources and affordability to adopt GSCM practices (Green et al., 2007; Qazi et al., 2022). A large organization is more

receptive to new opportunities and investments, which makes them invest in GSCM practices leading to sustainable performance. They have access to more significant resources, better funding opportunities, and professional expertise to innovate and implement cutting-edge technologies in their supply chain practices leading to improved performance compared to small and mid-sized organizations (Thoumy & Vachon, 2012; Yang & Wang, 2023). The firm size plays a vital role in responding to external pressure, which influences the selection of logistics channel operations (Saeed & Kersten, 2019; Song et al., 2017). Large organizations integrate green suppliers and customers into their supply chain for sustainable performance. On the contrary, small-sized businesses tend to pay less attention to environmental issues than mid- and large-sized organizations due to inadequate resources, capacity acquisitions, increased pressure than their counterparts, inadequate bargaining power or insufficient consumer pressure (Agi & Nishant, 2017). Small-sized organizations invest in GSCM practices based on the investments made and the return on investment for that program (Vijayvargy et al., 2017; Wu, 2013).

We defined firm age as the length of time the company has been in operation (Wang et al., 2020; Zheng et al., 2015). As the firm undergoes various stages during its lifecycle, with experience, the firm's age impacts the firm's expertise, resources, reputation, stakeholder relationships and market share, which determines the returns they obtain from innovations (D'Amato & Falivena, 2020). Past literature has studied firm age affects improved environment innovation and overall firm performance; however, the results are inconsistent (Yin et al., 2022). Yoger and more established businesses differ in ways that limit their ability to introduce new products to the market, practice social responsibility, or capitalize on discoveries to improve their financial performance. They may face an essential disadvantage as they have a lower absorptive capacity to acquire and retain external knowledge. In contrast, firms with more experience have a competitive advantage over new-age firms in managing supply chains and enhancing performance (Younis & Sundarakani, 2020). Thus, older organizations have more resources regarding established relations and accumulated knowledge that encourages practising green practices that ultimately lead to sustainable performance.

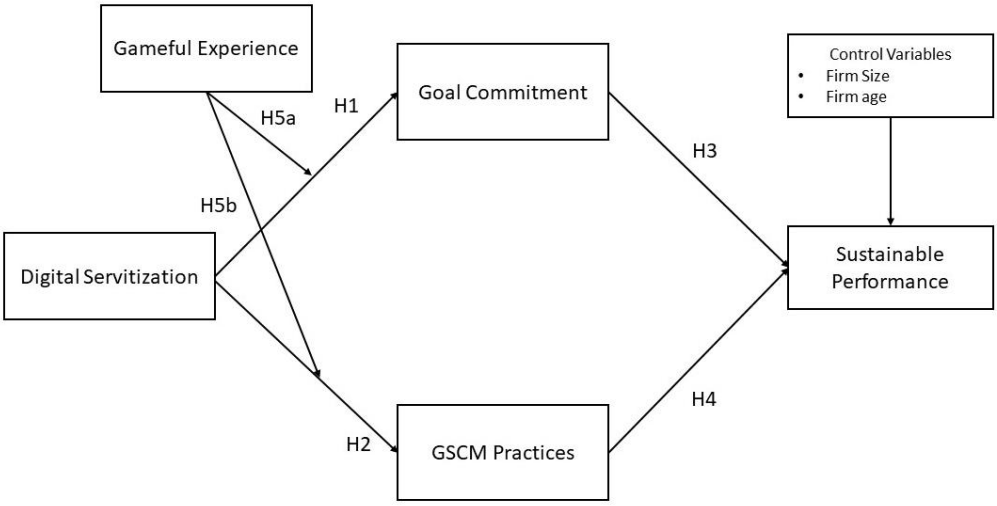

Figure 1: Proposed Research Model

4. Research design

4.1 Survey instrument development

To test our five hypotheses, we first defined the constructs and derived the items by thorou the extant marketing literature. We then developed an English language questionnaire suited to measure eight theoretical constructs. This consisted of a total of 22 questions divided into two parts; the first included questions related to the participants' demographics and the second consisted of measurement items. In addition, we administered the survey form only to participants who were fluent in the English language. We added some screening questions aimed at identifying and discarding any unsuitable participants. We measured the *digital servitization* constructs on a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). We measured the responses pertaining to the *goal commitment and GSCM practices* constructs using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We adapted the items for the *sustainable performance* constructs from Shao et al. (2022) and (D. D. H. Shin, 2019), the items for the *gameful experience* constructs from 2020). To verify the content validity of the survey instrument, we discussed our constructs and their measurement items with five industry experts and academicians; two experts in blockchain technology, two senior professors in the innovation and supply chain management area, and one professor in information technology. These experts guided us in evaluating the readability, clarity, and appropriateness of the items.

4.2 Sampling design

We selected our participants based on previous job roles and relevant experience to understand and practice digital transformation. Our target respondents were managers from FMCG firms from emerging economies. Our respondents presented different firms spread over different demographic characteristics.

4.3 Data collection

Our data collection process started on 17th August 2022 and ended on 25th November 2022. We collected data from various firms across the world who have recently worked on the principles of green supply chain management through digital transformation. A preliminary check was conducted with the managers using one on one interview (screening round) to find out the extent to which GSCM practices are followed and to what extent has digital servitization helped them. To establish the reliability of the measurement items through Cronbach's alpha, we first conducted a pilot study on a sample of 60 participants. We ensured that the respondents had prior knowledge of digital servitization and GSCM practices. We then sent the questionnaire to a total of 1300 respondents via an email that also described the purpose of our study and assured them of the confidentiality and anonymity of their information. The survey was floated based on the database received from a premier market research agency. We also shared the questionnaire across various social media platforms. After three reminders, 276 respondents returned the completed survey questionnaire; out of these responses, we found 254 to be usable. Out of all the responses, 81% were received by email, and 19% through social media. Table 1 presents the demographic profiles of our respondents.

Table 1. Demographic profiles of the respondents

Categories	Frequency
Gender	
Male	185
Female	69
Educational Qualification	
Undergraduate	134
Post-graduate	88
Doctoral degree	18
Other	14
Years of Experience	

0 to 5 years	75
6 to 10 years	48
11 to 15 years	59
16 to 20 years	41
More than 20 years	31

5. Data analysis

5.1 The measurement properties of the constructs

The values of the alpha (α) coefficient, scale composite reliability (SCR), and average variance extracted (AVE) for the first-order multi-item constructs of this study are reported in Appendix . All these measures were found to fall within their respective thresholds. The derived values were found to be reliable and valid measures of the individual constructs. The goodness of fit measures were found to be satisfactory. Next, we examined the discriminant validity of the constructs. We compared the square root of the AVE of each construct with the absolute value of the correlation of that factor's measure with all measures of the other factors in the model, as reported in Appendix.

5.2 Common method bias

Common method bias can be an issue in some studies. To check for its presence, we took the following steps. First, we performed Harman's one-factor test by loading all the measurement items of our research into an exploratory factor analysis. The maximum variance explained by a single factor was found to be 37.3%, which suggested the unlikeliness of common method bias affecting our study. Second, we performed a marker variable test with the aim of controlling for common method variance (CMV) by including, in the measurement model, a variable that was theoretically unrelated to the main constructs used in it. After performing this test, we did not find any potential effects that would indicate any significant amount of CMV. These findings indicated that common method bias was not a major issue in our study.

To check for causality, we evaluated assessment indices like Sympson's paradox ratio (SPR), the statistical suppression ratio (SSR), and the nonlinear bivariate causality direction ratio (NLBCDR), which we found to fall above the 0.7 threshold. Also, the R^2 contribution ratio was found to fall above the threshold of 0.9 (Table 2).

Table 2. Causality indices

Causality Assessment Indices	Values (Threshold Values, if any)
Sympson's Paradox Ratio (SPR)	0.812 (Acceptable if ≥ 0.7)
R^2 contribution ratio	0.932 (Acceptable if ≥ 0.9)
Statistical Suppression Ratio (SSR)	0.802 (Acceptable if ≥ 0.7)
Nonlinear bivariate causality direction ratio (NLBCDR)	0.714 (Acceptable if ≥ 0.7)

5.3 Validity and reliability analysis

We performed validity checks as per the guidelines of Hair et al. (2014). We determined convergent validity by calculating the factor loadings (above 0.5), composite scale reliability (above 0.70), and average variance extracted (AVE) (above 0.50). We then determined discriminant validity by comparing the AVE and correlations between the constructs. We found the factor loading values using varimax rotation, AVE scores, and composite scale reliability to be within the threshold. Hence, we found no convergent validity issues in the analysis. To check for reliability, we performed a Heterotrait-Monotrait (HTMT) Test, and found all the values to fall below the 0.85 threshold; see Appendix.

5.4 Hypotheses testing

We validated our research framework by means of the structural equation modeling (SEM) analysis of the data collected from our 254 valid responses. To test our hypotheses, we used the PLS-SEM technique with the Warp PLS 7.0 software. We found all the measures to fall under the threshold, thus ensuring a significant statistical model fit (Table 3).

Table 3. Model fit and quality indices

Model fit and quality indices	Values (Threshold Values if any)
Average Path Coefficient (APC)	0.528 ($p < 0.001$)
Average R^2	0.715 ($p < 0.001$)
Average block VIF	3.89 (Acceptable if value ≤ 5)
Tenenhaus GoF	0.442 (Large if value ≥ 0.36)

We checked the direct effect of the constructs using SEM, as per our hypotheses H1, H2, H3 and H4. These hypotheses posited digital servitization positively impact the sustainable performance of the firm. The relationship is shown both directly and indirectly. The study found supporting results for the mediating effect of goal commitment and GSCM practices.

The results were found to show that the application of digital servitization (β = 0.45, $p < 0.01$) has a positive influence on goal commitment, and GSCM practices (β = 0.25, $p < 0.01$). Also, goal commitment (β = 0.31, $p < 0.01$), and GSCM practices (β = 0.35, $p < 0.01$), have positive effects sustainable performance. We further used the moderating effect of gameful experience on the relationship between the digital servitization and goal commitment (β = 0.46, $p < 0.01$). However, we did not get supporting results for the moderating effect of gameful experience on the relationship between digital servitization and GSCM practices (β = 0.39, $p < 0.01$). Among the control variables selected for this study, firm size (β = 0.21, $p < 0.01$), while firm age (β = -0.003, $p < 0.01$) was found not to be suported. Table 4 presents a summary of our hypotheses testing.

Table 4. Structural estimates

Hypothesis	**Effect of**	**Effect On**	**β**	**p-value**	**Results**
H1	DS	GC	0.45	***	Supported
H2	DS	GSCMP	0.25	***	Supported
H3	GC	SP	0.31	*******	Supported
H4	GSCMP	SP	0.35	***	Supported
H5a	DS X GE	GC	0.46	***	Supported
H5b	DS X GE	GSCMP	0.09	*	Not Supported

Our findings validate the notion that the application of digital servitization has the potential to lead to improved goal commitment and GSCM practices which in turn positively impacts the sustainable performance. It is also important to understand that while sustainable performance might be the forefront of FMCG companies through digital servitization, it is also important to use gameful practices to improve the goal commitment of firms. The moderated mediated effect would then improve the process of achieving sustainable performance. Our results

provide counterintuitive argument that states that while the mediating effect of GSCM practices improves the sustainable performance directly but its gameful experience based moderated effect dampens the relationship between digital servitization and GSCM practices.

6. Discussion

The primary objective of this study is to understand the interrelationships between DS, GSCM practices, goal commitment, and sustainable performance. Furthermore, the moderating role of gameful experience is also investigated. This study draws theoretical support from self-determination theory and Goal setting theory.

Our findings indicate that digital servitization positively influences goal commitment. This implies a firm can strengthen its goal commitment by increasing the use of digital tools in servitization. Our findings align with Coreynen et al. (2017), who found that digital servitization plays a vital role in manufacturers' commitment to offering new services, which would provide a competitive advantage. In addition, Rifkin (2014) argues that firms can achieve the Goal of zero marginal cost of producing and upscaling service operations by appropriately using digital tools. Furthermore, a firm's commitment to product visibility (for example, product location and product condition) throughout the supply chain can be fulfilled by digital servitization (Baines & Lightfoot, 2014). Therefore, the firms that have invested in digital servitization are likely to achieve their goals in complex markets (Sklyar et al., 2019).

Next, businesses across the globe are adopting GSCM practices. One of the aims of adopting GSCM practices is to reduce carbon footprints. Our findings suggest that digital servitization can enhance the successful implementation of GSCM practices. That implies that firms using digital tools will have better prospects of adopting GSCM practices. Our findings are in alignment with previous research. For example, Marić & Opazo-Basáez (2019) show that the integration of digital technologies into reverse logistics services optimizes the overall reverse logistics process. In addition, digital servitization can improve other GSCM initiatives, such as reduction of energy consumption, environmentally friendly production processes, green and sustainable manufacturing systems, among others (Opazo-Basáez et al., 2018; Schiavone et al., 2022). Furthermore, Terzi et al. (2023) show that digital servitization can improve the circular economy and sustainable business performance in the automotive industry.

Further, the role of goal commitment in elevating performance is a well-researched area (for example, DeShon et al., 2004; Erez & Judge, 2001)). However, in the last few years, the firms

have focused on sustainable performance. Our findings indicate that goal commitment is positively associated with sustainable performance. That implies that if a firm is committed to its goals, the likelihood of sustainable performance is higher. Our finding is in line with previous studies. For example, (Adams et al., 2014) found that clear and measurable goals improve performance on various sustainability dimensions. In addition, Lamichhane et al. (2021) observed that Goal specific approach improves sustainable performance.

Next, the adoption of GSCM practices is forward-looking, and the firms that adopt GSCM practices are likely to gain a sustainable competitive advantage ((Laosirihongthong et al., 2013). Our findings reveal that GSCM practices have a positive influence on sustainable performance. That means the firms adopting more GSCM practices will have sustainable performance. GSCM practices can include reducing waste, energy consumption, and fuel consumption, promoting the reuse of products (or parts/components), and reducing carbon emissions. The adoption of GSCM practices leads to better financial, environmental, and social performance.

Moreover, the customers also have favourable attitudes towards the firms that adopt GSCM practices which improves their brand image (Hazen et al., 2012). Therefore, it is highly likely that adopting GSCM practices will provide firms with a sustainable competitive advantage (Mitra & Datta, 2014). Consistent with our findings, Ofori Antwi et al. (2022) show that firms engaged in GSCM practices gain sustainable performance in the mining industry . Furthermore, another study by Zaid et al. (2018), based on the primary data from the food, chemical, and pharma sectors), found that GSCM practices positively influence sustainable performance.

Finally. the use of gamification in the supply chain context is limited. However, researchers investigated its role in production, logistics, and warehousing(Bahr et al., 2021; Warmelink et al., 2020). Our findings indicate that gameful experience moderates the relationship between digital servitization and goal commitment. This result is in line with the previous studies. For example, Landers et al. (2017) found that using leaderboards motivated employees to improve their task performance by setting up their goals at the top of the leaderboard. In addition, Hamari (2017) observed that a gameful experience increases user engagement, service experience, and goal commitment. Similarly, Garcia Margo and Pinar (2019) note that manufacturing firms may use gamification strategies to improve their servitization process. Furthermore, Harrmann et al. (2022) found that digital technology is a driver in the servitization of the manufacturing industry.

Our other finding suggests that gameful experiences do not moderate the relationship between digital servitization and GSCM practices. Our result contrasts with the conclusions of previous studies. For example, Paravizo et al. (2018) argue that gamification enables sustainability and innovation in manufacturing firms. Souza et al. (2020) note that gamification has the potential to promote green behaviour among employees and customers. The probable reason for our contrasting finding is our respondents may not have comprehended the relationship between digital servitization and GSCM practices. We clarified it in a few follow-up calls with our respondents. Since digital servitization is a relatively new concept, our respondents did not fully understand how a gameful experience could enhance GSCM practices.

6.1 **Theoretical Contributions**

This research has multiple academic implications. This study uniquely contributes to the sustainable supply chain, servitization, and gamification literature. Sustainable supply chain management practices recently received significant attention of researchers, and hence, several attempts were made to explore how to achieve sustainability in supply chain management (Warmelink et al., 2020;Tayal et al., 2022). In the existing literature, studies also investigated how to use technology to achieve sustainable supply chain management. This study contributes to the sustainable supply literature by investigating how servitization play crucial role in achieving green supply chain management. This study also uniquely contributes to the existing literature by examining the role of gamification in achieving sustainable supply chain management.

This study also contributes to innovative technology adoption literature. Organisations are using innovative technology such as, artificial intelligence, IoT, machine learning, drones, augmented reality and virtual reality to enhance supply chain functions. Servitization is one the of the innovative solutions to achieve excellence in supply chain management. This study uniquely contributes to the technology transformation literature by examining g how servitization helps in achieving sustainable supply chain management which ultimately leads to sustainable performance.

This study further contributes to the emerging gamification literature. Recently, studies investigated the role of gamification in different contexts (Huotari and Hamari, 2017; Behl et al., 2022b). However, limited studies investigated the role of gamification in supply chain contexts and as per authors knowledge, no study examined how gamification can play a crucial role in achieving supply chain management. Hence, this study contributes to the literature by investigating the effect of gamification in achieving green supply chain management.

Finally this study contributes to the self-determination theory (SDT) and goal-setting theory (GST). Both SDT and GST have been used in existing literature to understand the role of innovation in enhancing performance. This study uniquely contributes to the literature by confirming that when competent employees are given autonomy and relatedness to the organization, they are likely to develop innovative practices that will improve overall performance. The study also highlights that setting up a common goal help in achieving better performance especially sustainable performance. Hence, this study extends the SDT and GST literature by using these theories as base theory to investigate the role of gamification and servitization in achieving sustainable supply chain management.

6.2 **Practical Contributions**

Practically, the study provides directions to the organisation to empower supply chain management and to achieve sustainable performance. The study's findings help organisations develop effective sustainable supply chain management strategies. The current study investigates the role of digital servitization on sustainable performance through GSCM practices and goal commitment. It also examines the impact of gameful experience on the relationships between DS-goal commitment and DS-GSCM practices. The supply chain managers can devise games using digital tools focusing on innovation, the environment, society, goals, and economic attributes. Such experience is expected to motivate employees to work towards goals specified by the organization. Furthermore, such experience would also generate ideas for adopting GSCM practices.

The results suggest that digital servitization significantly impacts goal commitment and GSCM, ultimately leading to sustainable supply chain performance. Hence, organisation should use innovative technology such as artificial intelligence, IoT, drone, cloud computing, blockchain and metaverse to achieve sustainable supply chain management. To adopt digital servitization,organisations need to assess your existing supply chain processes and identify areas that can be improved with the help of digital technologies. Organisations should partner with technology providers and other stakeholders in supply chain to support digital servitization efforts. This will help you leverage the expertise of these partners and accelerate adoption of digital technologies and services. Organisations should develop a comprehensive digital servitization strategy that aligns with business objectives, supply chain goals, and customer expectations. This should include a roadmap for adopting the necessary technologies and services and metrics to measure success. Moreover, organisations should develop and implement digital services that support supply chain operations. This may include predictive

maintenance, real-time monitoring, supply chain visibility, and analytics-driven decision-making.

The results further suggested that gamification is crucial for sustainable supply chain management. Hence, organisations should add gamification element in supply chain management strategy. By using gamification to achieve sustainable supply chain management, companies can create a culture of sustainability that engages stakeholders and drives positive environmental and social impact. By incentivizing sustainable behaviors and actions, companies can reduce their environmental impact, improve social responsibility, and gain a competitive advantage in their industry.

Organisations should design a game that incentivizes sustainable behaviors and actions among these stakeholders. The game should include clear rules, objectives, and rewards. Consider incorporating elements such as points, badges, leaderboards, and rewards to incentivize engagement. Organisations should also integrate the game into supply chain management practices. This may involve incorporating the game into training programs, employee evaluations, or supplier engagement programs. Organisation should finally collect the data to identify areas for improvement and adjust the game to incentivize the behaviors and actions that will drive sustainability.

7. Conclusion and Future Scope of the Study

This study aims to investigate the effect of digital servitization on green supply chain management and goal commitment, which ultimately leads to sustainable performance. The study also investigates role of gamification in achieving sustainable supply chain management. A framework was proposed using self-determination and goal-setting theories as underpinning theories. The results of cross-section study findings suggested that servitization significantly enhance sustainable supply chain management practices and goal commitment to achieve sustainable performance. The results further suggested that gamification play crucial role in achieving sustainable performance. This study significantly contributes to the digital innovation, green supply chain management, gamification literature. The study findings help organisations use innovative technology and gamification to achieve green supply chain.

Although, present study adds an essential empirical addition to the literature but with some constraints. Firstly, our study relied on cross-sectional data, which can only reveal associations between factors; therefore, a longitudinal survey-based or experimental study might be used in

future research to solve this restriction. Moreover, our model may further be enhanced by looking at various other intervening variables effects that may impact the relationship between input and output variables. Further, the model proposed in this study can be investigated in the other contexts to generalise the findings.

References

Abou-Foul, M., Ruiz-Alba, J. L., & López-Tenorio, P. J. (2023). The impact of artificial intelligence capabilities on servitization: The moderating role of absorptive capacity-A dynamic capabilities perspective. *Journal of Business Research*, *157*, 113609.

Adams, C. A., Muir, S., & Hoque, Z. (2014). Measurement of sustainability performance in the public sector. *Sustainability Accounting, Management and Policy Journal*, *5*(1), 46–67. https://doi.org/10.1108/SAMPJ-04-2012-0018/FULL/PDF

Agi, M. A. N., & Nishant, R. (2017). Understanding influential factors on implementing green supply chain management practices: An interpretive structural modelling analysis. *Journal of Environmental Management*, *188*, 351–363.

Ambec, S., & Lanoie, P. (2008). Does It Pay to Be Green? A Systematic Overview. *Academy of Management Perspectives*, *22*(4), 45–62. http://www.jstor.org/stable/27747478

Andrews, D., Dmitrijeva, J., Bigdeli, A. Z., & Baines, T. (2018). Snakes and ladders in servitization: using a game to capture inhibitors and enablers of transformation. *Research-Technology Management*, *61*(6), 37–47.

Azevedo, S. G., Carvalho, H., & Machado, V. C. (2011). The influence of green practices on supply chain performance: A case study approach. *Transportation Research Part E: Logistics and Transportation Review*, *47*(6), 850–871.

Bahr, W., Mavrogenis, V., & Sweeney, E. (2021). Gamification of warehousing: exploring perspectives of warehouse managers in the UK. *Https://Doi.Org/10.1080/13675567.2021.1892042*, *25*(3), 247–259. https://doi.org/10.1080/13675567.2021.1892042

Bahr, W., Mavrogenis, V., & Sweeney, E. (2022). Gamification of warehousing: exploring perspectives of warehouse managers in the UK. *International Journal of Logistics Research and Applications*, *25*(3), 247–259.

Baines, T., & Lightfoot, H. W. (2014). Servitization of the manufacturing firm: Exploring the operations practices and technologies that deliver advanced services. *International Journal of Operations and Production Management*, *34*(1), 2–35. https://doi.org/10.1108/IJOPM-02-2012-0086/FULL/PDF

Baines, T., Ziaee Bigdeli, A., Bustinza, O. F., Shi, V. G., Baldwin, J., & Ridgway, K. (2017). Servitization: revisiting the state-of-the-art and research priorities. *International Journal of Operations & Production Management*, *37*(2), 256–278. https://doi.org/10.1108/IJOPM-06-2015-0312

Balasubramanian, S., & Shukla, V. (2017). Green supply chain management: an empirical investigation on the construction sector. *Supply Chain Management: An International Journal*, *22*(1), 58–81. https://doi.org/10.1108/SCM-07-2016-0227

Bandinelli, R., & Gamberi, V. (2012). Servitization in oil and gas sector: outcomes of a case study research. *Journal of Manufacturing Technology Management*, *23*(1), 87–102. https://doi.org/10.1108/17410381211196302

Behl, A., Jayawardena, N. S., Pereira, V., & Sampat, B. (2022a). Assessing retailer readiness to use blockchain technology to improve supply chain performance. *Journal of Enterprise Information Management*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/JEIM-07-2022-0242

Behl, A., Jayawardena, N., Ishizaka, A., Gupta, M., & Shankar, A. (2022b). Gamification and gigification: A multidimensional theoretical approach. *Journal of Business Research*, *139*, 1378-1393.

Benedettini, O., Swink, M., & Neely, A. (2017). Examining the influence of service additions on manufacturing firms' bankruptcy likelihood. *Industrial Marketing Management*, *60*, 112–125.

Chardine-Baumann, E., & Botta-Genoulaz, V. (2014). A framework for sustainable performance assessment of supply chain management practices. *Computers & Industrial Engineering*, *76*(1), 138–147. https://doi.org/10.1016/J.CIE.2014.07.029

Chirumalla, K., Leoni, L., & Oghazi, P. (2023). Moving from servitization to digital servitization: Identifying the required dynamic capabilities and related microfoundations to facilitate the transition. *Journal of Business Research*, *158*, 113668. https://doi.org/https://doi.org/10.1016/j.jbusres.2023.113668

Coreynen, W., Matthyssens, P., & van Bockhaven, W. (2017). Boosting servitization through digitization: Pathways and dynamic resource configurations for manufacturers. *Industrial Marketing Management*, *60*, 42–53. https://doi.org/10.1016/J.INDMARMAN.2016.04.012

D'Amato, A., & Falivena, C. (2020). Corporate social responsibility and firm value: Do firm size and age matter? Empirical evidence from European listed companies. *Corporate Social Responsibility and Environmental Management*, *27*(2), 909–924.

Deci, E. L., & Ryan, R. M. (1985). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality*, *19*(2), 109–134.

DeShon, R. P., Kozlowski, S. W. J., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2004). A multiple-goal, multilevel model of feedback effects on the regulation of individual and team performance. *Journal of Applied Psychology*, *89*(6), 1035–1056. https://doi.org/10.1037/0021-9010.89.6.1035

Erez, A., & Judge, T. A. (2001). Relationship of core self-evaluations to goal setting, motivation, and performance. *Journal of Applied Psychology*, *86*(6), 1270–1279. https://doi.org/10.1037/0021-9010.86.6.1270

Fichman, R. G., dos Santos, B. L., & Zheng, Z. (Eric). (2014). Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum on JSTOR. *MIS Quarterly*, *38*(2), 329–354. https://www.jstor.org/stable/26634929

Geng, R., Mansouri, S. A., & Aktas, E. (2017). The relationship between green supply chain management and performance: A meta-analysis of empirical evidences in Asian emerging economies. *International Journal of Production Economics*, *183*, 245–258. https://doi.org/https://doi.org/10.1016/j.ijpe.2016.10.008

Green, K. W., Whitten, D., & Inman, R. A. (2007). The impact of timely information on organizational performance in a supply chain. *Production Planning & Control*, *18*(4), 274–282. https://doi.org/10.1080/09537280701243926

Haavisto, I., & Goentzel, J. (2015). Measuring humanitarian supply chain performance in a multi-goal context. *Journal of Humanitarian Logistics and Supply Chain Management*, *5*(3), 300–324. https://doi.org/10.1108/JHLSCM-07-2015-0028

Haavisto, I., & Goentzel, J. (2015). Measuring humanitarian supply chain performance in a multi-goal context. *Journal of Humanitarian Logistics and Supply Chain Management*, *5*(3), 300–324. https://doi.org/10.1108/JHLSCM-07-2015-0028/FULL/PDF

Habib, M. A., Balasubramanian, S., Shukla, V., Chitakunye, D., & Chanchaichujit, J. (2022). Practices and performance outcomes of green supply chain management initiatives in the garment industry. *Management of Environmental Quality: An International Journal*, *33*(4), 882–912. https://doi.org/10.1108/MEQ-08-2021-0189

Hamari, J. (2017). Do badges increase user activity? A field experiment on the effects of gamification. *Computers in Human Behavior*, *71*, 469–478. https://doi.org/10.1016/J.CHB.2015.03.036

Harrmann, L. K., Eggert, A., & Böhm, E. (2022). Digital technology usage as a driver of servitization paths in manufacturing industries. *European Journal of Marketing*, *57*(3), 834–857. https://doi.org/10.1108/EJM-11-2021-0914/FULL/PDF

Hazen, B. T., Wu, Y., Cegielski, C. G., Jones-Farmer, L. A., & Hall, D. J. (2012). Consumer reactions to the adoption of green reverse logistics. *The International Review of Retail, Distribution and Consumer Research* , *22*(4), 417–434. https://doi.org/10.1080/09593969.2012.690777

Hense, J., Klevers, M., Sailer, M., Horenburg, T., Mandl, H., & Günthner, W. (2014). *Using Gamification to Enhance Staff Motivation in Logistics BT - Frontiers in Gaming Simulation* (S. A. Meijer & R. Smeds (eds.); pp. 206–213). Springer International Publishing.

Huotari, K., & Hamari, J. (2017). A definition for gamification: anchoring gamification in the service marketing literature. *Electronic Markets*, *27*(1), 21–31.

Ivanov, D., Dolgui, A., & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. *International Journal of Production Research*, *57*(3), 829–846.

Kamble, S., Gunasekaran, A., & Dhone, N. C. (2019). Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies. *Https://Doi.Org/10.1080/00207543.2019.1630772*, *58*(5), 1319–1337. https://doi.org/10.1080/00207543.2019.1630772

Klemke, R., Kravcik, M., & Bohuschke, F. (2014). *Energy-Efficient and Safe Driving Using a Situation-Aware Gamification Approach in Logistics BT - Games and Learning Alliance* (A. De Gloria (ed.); pp. 3–15). Springer International Publishing.

Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research*, *104*, 380–392. https://doi.org/https://doi.org/10.1016/j.jbusres.2019.06.027

Korn, O., & Schmidt, A. (2015). Gamification of business processes: Re-designing work in production and service industry. *Procedia Manufacturing*, *3*, 3424–3431.

Kreye, M. E., Roehrich, J. K., & Lewis, M. A. (2015). Servitising manufacturers: the impact of service complexity and contractual and relational capabilities. *Production Planning & Control*, *26*(14–15), 1233–1246. https://doi.org/10.1080/09537287.2015.1033489

Lamichhane, S., Eğilmez, G., Gedik, R., Bhutta, M. K. S., & Erenay, B. (2021). Benchmarking OECD countries' sustainable development performance: A goal-specific principal component analysis approach. *Journal of Cleaner Production*, *287*, 125040. https://doi.org/10.1016/J.JCLEPRO.2020.125040

Landers, R. N., Bauer, K. N., & Callan, R. C. (2017). Gamification of task performance with leaderboards: A goal setting experiment. *Computers in Human Behavior*, *71*, 508–515. https://doi.org/10.1016/J.CHB.2015.08.008

Laosirihongthong, T., Adebanjo, D., & Choon Tan, K. (2013). Green supply chain management practices and performance. *Industrial Management & Data Systems*, *113*(8), 1088–1109. https://doi.org/10.1108/IMDS-04-2013-0164/FULL/PDF

Latham, G. P., & Wexley, K. N. (1993). *Increasing productivity through performance appraisal*. Prentice Hall.

Leyva-de la Hiz, D. I., & Bolívar-Ramos, M. T. (2022). The inverted U relationship between green innovative activities and firms' market-based performance: The impact of

firm age. *Technovation*, *110*, 102372. https://doi.org/https://doi.org/10.1016/j.technovation.2021.102372

Lightfoot, H., Baines, T., & Smart, P. (2013). The servitization of manufacturing. *International Journal of Operations & Production Management*, *33*(11/12), 1408–1434. https://doi.org/10.1108/IJOPM-07-2010-0196

Locke, E. A. (1968). Toward a theory of task motivation and incentives. *Organizational Behavior and Human Performance*, *3*(2), 157–189.

Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist*, *57*(9), 705.

Locke, E. A., & Latham, G. P. (2006). New directions in goal-setting theory. *Current Directions in Psychological Science*, *15*(5), 265–268.

Marić, J., & Opazo-Basáez, M. (2019). Green Servitization for Flexible and Sustainable Supply Chain Operations: A Review of Reverse Logistics Services in Manufacturing. *Global Journal of Flexible Systems Management*, *20*(1), 65–80. https://doi.org/10.1007/S40171-019-00225-6/TABLES/1

Min, H., & Zhou, G. (2002). Supply chain modeling: past, present and future. *Computers & Industrial Engineering*, *43*(1–2), 231–249. https://doi.org/10.1016/S0360-8352(02)00066-9

Mitra, S., & Datta, P. P. (2014). Adoption of green supply chain management practices and their impact on performance: an exploratory study of Indian manufacturing firms. *International Journal of Production Research*, *52*(7), 2085–2107. https://doi.org/10.1080/00207543.2013.849014

Neto, H. M., Leite, R. M., Costa, D. B., & Durão, F. (2014). Visual communication panels for production control using gamification techniques. *22nd Annu. Conf. Int. Gr. Lean Constr. Underst. Improv. Proj. Based Prod. IGLC*, 689–702.

Niesten, E., Jolink, A., Lopes de Sousa Jabbour, A. B., Chappin, M., & Lozano, R. (2017). Sustainable collaboration: The impact of governance and institutions on sustainable performance. *Journal of Cleaner Production*, *155*, 1–6. https://doi.org/10.1016/J.JCLEPRO.2016.12.085

Opazo-Basáez, M., Vendrell-Herrero, F., & Bustinza, O. F. (2018). Uncovering Productivity Gains of Digital and Green Servitization: Implications from the Automotive Industry. *Sustainability 2018, Vol. 10, Page 1524*, *10*(5), 1524. https://doi.org/10.3390/SU10051524

Paravizo, E., Chaim, O. C., Braatz, D., Muschard, B., & Rozenfeld, H. (2018). Exploring gamification to support manufacturing education on industry 4.0 as an enabler for innovation and sustainability. *Procedia Manufacturing*, *21*, 438–445. https://doi.org/10.1016/J.PROMFG.2018.02.142

Paschou, T., Rapaccini, M., Adrodegari, F., & Saccani, N. (2020). Digital servitization in manufacturing: A systematic literature review and research agenda. *Industrial Marketing Management*, *89*, 278–292. https://doi.org/https://doi.org/10.1016/j.indmarman.2020.02.012

Pereira, V., Behl, A., Jayawardena, N., Laker, B., Dwivedi, Y. K., & Bhardwaj, S. (2022). The art of gamifying digital gig workers: a theoretical assessment of evaluating engagement and motivation. *Production Planning & Control*, 1–17.

Putz, L.-M., Hofbauer, F., & Mates, M. (2019). A vignette study among order pickers about the acceptance of gamification. *GamiFIN*, 154–166.

Qazi, S. A., Moazzam, M., Ahmed, W., & Raziq, M. M. (2022). Green in-store operations and sustainability performance: the moderating role of organization size. *International Journal of Productivity and Performance Management*, *ahead-of-p*(ahead-of-print). https://doi.org/10.1108/IJPPM-01-2022-0017

Rapaccini, M., & Visintin, F. (2015). Devising hybrid solutions: an exploratory framework. *Production Planning & Control*, *26*(8), 654–672.

Rehman Khan, S. A., & Yu, Z. (2021). Assessing the eco-environmental performance: an PLS-SEM approach with practice-based view. *International Journal of Logistics Research and Applications*, *24*(3), 303–321.

Remi-Omosowon, A., Cant, R., & Langensiepen, C. (2016). Applying gamification principles to a container loading system in a warehouse environment. *2016 UKSim-AMSS 18th International Conference on Computer Modelling and Simulation (UKSim)*, 79–84.

Rifkin, J. (2014). *The zero marginal cost society: The internet of things, the collaborative commons, and the eclipse of capitalism*. Palgrave Macmillan, New York.

Roehrich, J. K., Hoejmose, S. U., & Overland, V. (2017). Driving green supply chain management performance through supplier selection and value internalization. *International Journal of Operations & Production Management*, *37*(4), 489–509. https://doi.org/10.1108/IJOPM-09-2015-0566

Ryan, R. M. (1995). Psychological needs and the facilitation of integrative processes. *Journal of Personality*, *63*(3), 397–427.

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, *57*(7), 2117–2135.

Saeed, M. A., & Kersten, W. (2019). Drivers of Sustainable Supply Chain Management: Identification and Classification. In *Sustainability* (Vol. 11, Issue 4). https://doi.org/10.3390/su11041137

Schiavone, F., Leone, D., Caporuscio, A., & Lan, S. (2022). Digital servitization and new sustainable configurations of manufacturing systems. *Technological Forecasting and Social Change*, *176*, 121441. https://doi.org/10.1016/J.TECHFORE.2021.121441

Schmidt, C. G., Foerstl, K., & Schaltenbrand, B. (2017). The supply chain position paradox: green practices and firm performance. *Journal of Supply Chain Management*, *53*(1), 3–25.

Shah, S. A. A., Jajja, M. S. S., Chatha, K. A., & Farooq, S. (2020). Servitization and supply chain integration: An empirical analysis. *International Journal of Production Economics*, *229*, 107765. https://doi.org/https://doi.org/10.1016/j.ijpe.2020.107765

Shang, K.-C., & Tseng, W.-J. (2010). A risk analysis of stevedoring operations in seaport container terminals. *Journal of Marine Science and Technology*, *18*(2), 6.

Shankar, A., Tiwari, A. K., & Gupta, M. (2022). Sustainable mobile banking application: A text mining approach to explore critical success factors. *Journal of Enterprise Information Management*, *35*(2), 414-428.

Sklyar, A., Kowalkowski, C., Tronvoll, B., & Sörhammar, D. (2019). Organizing for digital servitization: A service ecosystem perspective. *Journal of Business Research*, *104*, 450–460. https://doi.org/10.1016/J.JBUSRES.2019.02.012

Slack, N. (2005). *Patterns of Servitization: Beyond products and service. An initial report on initial exploratory work undertaken January-April 2004*. Institute for Manufacturing, CUEA.

Song, Y., Feng, T., & Jiang, W. (2017). The Influence of Green External Integration on Firm Performance: Does Firm Size Matter? In *Sustainability* (Vol. 9, Issue 8). https://doi.org/10.3390/su9081328

Souza, V. S., Marques, S. R. B. de V., & Veríssimo, M. (2020). How can gamification contribute to achieve SDGs? : Exploring the opportunities and challenges of ecogamification for tourism. *Journal of Hospitality and Tourism Technology*, *11*(2), 255–276. https://doi.org/10.1108/JHTT-05-2019-0081/FULL/PDF

Tayal, S., Rajagopal, K., & Mahajan, V. (2022). Modernization with Gamification on Industry 4.0 in Supply Chain Management 4.0. *2022 6th International Conference on Electronics, Communication and Aerospace Technology*, 292–299. https://doi.org/10.1109/ICECA55336.2022.10009424

Teras, M., Reiners, T., Coldham, G., & Wood, L. C. (2016). NDIVE: Gamified virtual reality environment for Logistics and Supply Chain Management training. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 738–744.

Terzi, S., Jankovic-Zugic, A., Medic, N., Pavlovic, M., Todorovic, T., & Rakic, S. (2023). Servitization 4.0 as a Trigger for Sustainable Business: Evidence from Automotive Digital Supply Chain. *Sustainability 2023, Vol. 15, Page 2217*, *15*(3), 2217. https://doi.org/10.3390/SU15032217

Thoumy, M., & Vachon, S. (2012). Environmental projects and financial performance: Exploring the impact of project characteristics. *International Journal of Production Economics*, *140*(1), 28–34. https://doi.org/https://doi.org/10.1016/j.ijpe.2012.01.014

Tomé Klock, A. C., Wallius, E., & Hamari, J. (2021). Gamification in freight transportation: extant corpus and future agenda. *International Journal of Physical*

Distribution & Logistics Management, *51*(7), 685–710. https://doi.org/10.1108/IJPDLM-04-2020-0103

Vendrell-Herrero, F., Bustinza, O. F., Parry, G., & Georgantzis, N. (2017). Servitization, digitization and supply chain interdependency. *Industrial Marketing Management*, *60*, 69–81. https://doi.org/https://doi.org/10.1016/j.indmarman.2016.06.013

Vijayvargy, L., Thakkar, J., & Agarwal, G. (2017). Green supply chain management practices and performance. *Journal of Manufacturing Technology Management*, *28*(3), 299–323. https://doi.org/10.1108/JMTM-09-2016-0123

Wagstaff, S., Burton, J., & Zolkiewski, J. (2021). Tensions and territoriality: the dark side of servitization. *Journal of Business & Industrial Marketing*, *36*(10), 1755–1766.

Wang, C., Zhang, Q., & Zhang, W. (2020). Corporate social responsibility, Green supply chain management and firm performance: The moderating role of big-data analytics capability. *Research in Transportation Business & Management*, *37*, 100557. https://doi.org/https://doi.org/10.1016/j.rtbm.2020.100557

Wanick, V., & Bui, H. (2019). Gamification in Management: a systematic review and research directions. *International Journal of Serious Games*, *6*(2 SE-Special Issue on Gamification of Industrial Systems), 57–74. https://doi.org/10.17083/ijsg.v6i2.282

Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2020). Gamification of production and logistics operations: Status quo and future directions. *Journal of Business Research*, *106*, 331–340. https://doi.org/10.1016/J.JBUSRES.2018.09.011

Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. (2020). Gamification of production and logistics operations: Status quo and future directions. *Journal of Business Research*, *106*, 331–340. https://doi.org/https://doi.org/10.1016/j.jbusres.2018.09.011

Winkelhaus, S., & Grosse, E. H. (2020). Logistics 4.0: a systematic review towards a new logistics system. *International Journal of Production Research*, *58*(1), 18–43.

Wong, C., Skipworth, H., Godsell, J., & Achimugu, N. (2012). Towards a theory of supply chain alignment enablers: A systematic literature review. *Supply Chain Management*, *17*(4), 419–437. https://doi.org/10.1108/13598541211246567/FULL/PDF

Wu, G. (2013). The influence of green supply chain integration and environmental uncertainty on green innovation in Taiwan's IT industry. *Supply Chain Management: An International Journal*, *18*(5), 539–552. https://doi.org/10.1108/SCM-06-2012-0201

Xing, Y., Liu, Y., Tarba, S., & Cooper, S. C. L. (2017). Servitization in mergers and acquisitions: Manufacturing firms venturing from emerging markets into advanced economies. *International Journal of Production Economics*, *192*, 9–18. https://doi.org/https://doi.org/10.1016/j.ijpe.2016.12.010

Yang, X., & Wang, J. (2023). The relationship between sustainable supply chain management and enterprise economic performance: does firm size matter? *Journal of Business & Industrial Marketing*, *38*(3), 553–567. https://doi.org/10.1108/JBIM-04-2021-0193

Yildiz Çankaya, S., & Sezen, B. (2019). Effects of green supply chain management practices on sustainability performance. *Journal of Manufacturing Technology Management*, *30*(1), 98–121. https://doi.org/10.1108/JMTM-03-2018-0099

Younis, H., & Sundarakani, B. (2020). The impact of firm size, firm age and environmental management certification on the relationship between green supply chain practices and corporate performance. *Benchmarking: An International Journal*, *27*(1), 319–346.

Younis, H., Sundarakani, B., & Vel, P. (2016). The impact of implementing green supply chain management practices on corporate performance. *Competitiveness Review*, *26*(3), 216–245. https://doi.org/10.1108/CR-04-2015-0024

Zaid, A. A., Jaaron, A. A. M., & Bon, A. T. (2018). The impact of green human resource management and green supply chain management practices on sustainable performance: An empirical study. *Journal of Cleaner Production*, *204*, 965–979.

Zheng, W., Singh, K., & Mitchell, W. (2015). Buffering and enabling: The impact of interlocking political ties on firm survival and sales growth. *Strategic Management Journal*, *36*(11), 1615–1636.

Zhu, Q., Sarkis, J., & Lai, K. (2012). Examining the effects of green supply chain management practices and their mediations on performance improvements. *International*

Journal of Production Research, *50*(5), 1377–1394. https://doi.org/10.1080/00207543.2011.571937

Zhu, Q., Sarkis, J., Lai, K., & Geng, Y. (2008). The role of organizational size in the adoption of green supply chain management practices in China. *Corporate Social Responsibility and Environmental Management*, *15*(6), 322–337.

Ziaee Bigdeli, A., Kapoor, K., Schroeder, A., & Omidvar, O. (2021). Exploring the root causes of servitization challenges: an organizational boundary perspective. *International Journal of Operations & Production Management*, *41*(5), 547–573.

Appendix

Convergent Validity

Items	Factor Loadings	Variance	Error	AVE	SCR
SP1	0.7	0.49	0.51	0.6648	0.946699
SP2	0.76	0.5776	0.4224		
SP3	0.89	0.7921	0.2079		
SP4	0.81	0.6561	0.3439		
SP5	0.87	0.7569	0.2431		
SP6	0.8	0.64	0.36		
SP7	0.8	0.64	0.36		
SP8	0.81	0.6561	0.3439		
SP9	0.88	0.7744	0.2256		
DS1	0.84	0.7056	0.2944	0.675633	0.925583

DS2	0.81	0.6561	0.3439		
DS3	0.72	0.5184	0.4816		
DS4	0.91	0.8281	0.1719		
DS5	0.8	0.64	0.36		
DS6	0.84	0.7056	0.2944		
GSCMP1	0.87	0.7569	0.2431	0.68326	0.91504
GSCMP2	0.78	0.6084	0.3916		
GSCMP3	0.85	0.7225	0.2775		
GSCMP4	0.82	0.6724	0.3276		
GSCMP5	0.81	0.6561	0.3439		
GE1	0.82	0.6724	0.3276	0.686433	0.928958
GE2	0.75	0.5625	0.4375		
GE3	0.89	0.7921	0.2079		
GE4	0.86	0.7396	0.2604		
GE5	0.88	0.7744	0.2256		
GE6	0.76	0.5776	0.4224		
GC1	0.83	0.6889	0.3111	0.64442	0.900442
GC2	0.79	0.6241	0.3759		
GC3	0.79	0.6241	0.3759		
GC4	0.85	0.7225	0.2775		
GC5	0.75	0.5625	0.4375		

Divergent Validity

	DS	GC	GSCMP	SP	GE
DS	0.69				
GC	0.43	0.73			
GSCMP	0.35	0.24	0.77		
SP	0.31	0.42	0.47	0.64	
GE	0.39	0.25	0.36	0.19	0.69

HTMT Results

	DS	GC	GSCMP	SP	GE
DS	0.56				
GC	0.45	0.61			
GSCMP	0.23	0.22	0.57		
SP	0.37	0.36	0.41	0.63	
GE	0.47	0.46	0.26	0.23	0.53