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Procurement 4.0 and Sustainable Supply Chain Performance: The Mediating Role of Procurement Process Optimization (PPO)

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ABSTRACT

The problem statement establishes the direction to assess the complex relationships between Procurement 4.0, Sustainable Supply Chain Performance, and the Procurement Process Optimization within the context of modern supply chain management. This study will help organizations in directional understanding about, how to create synergy between the procurement practices and sustainability goals, while emphasizing the role of procurement process optimization and organizational capabilities. We review food manufacturers in Pakistan and dissect study results utilizing the "PLS-SEM" way to deal with test the research hypothesis and the theoretical framework. Finally a simulation of the sample business process supported in the valuation of how the procurement 4.0 automation can enhance the procurement cycle and further progress the sustainability performance in supply chain. This empirical study shows that procurement process optimization serves as a mediator in this conceptual framework and that Procurement 4.0 strategy, planning, and performance review positively influence the performance of a sustainable supply chain. We are able to develop a solid plan to direct future SSCM and SSCP research based on the trends and gaps that we discovered through our analysis.

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1. Introduction

According to Althabatah, Franzoi, Menezes, and Kerbache (2023), in today's global business landscape, the complex market requires businesses to become more effective and resilient in order for them to survive in an intricate market that is constantly changing dynamics and highly competitive. Accordingly, it is necessary to streamline the operations to make them more adaptable to the environment's constant change. However, there are numerous methods for increasing business efficiency, with one of the most essential aspects being to improve the procurement procedure (Bienhaus & Haddud, 2018a; Simões, Madureira, & Amorim, 2023). Efficient procurement can fundamentally affect the organization's strategic purpose, like optimizing costs, streamlining the processes, and ensuring the right supplies at the right time to continue the production pace at the optimum level (Corboș, Bunea, & Jiroveanu, 2023). The developing excursion of the acquisition was Procurement 1.0 to Procurement 4.0 (Althabatah, Franzoi, et al., 2023; Bienhaus & Haddud, 2018a; Mavidis & Folinas, 2022). The essential objectives of procurement 1.0 were cost decrease and keeping an autonomous provider relationship. To oversee supplies, Procurement 2.0 is tied by laying out fair worth and developing cooperative connections. Given e-procurement frameworks Bag,

Dhamija, Gupta, and Sivarajah (2021), Procurement 3.0 deals with the whole buying cycle and has multi-organization abilities (Mavidis & Folinas, 2022). Procurement 4.0 is the most recent digitization approach of all business cycles and reconciliation of the information across supply chains to acquire the incentive (Althabatah, Franzoi, et al., 2023; Mavidis & Folinas, 2022).

Effective procurement entails various strategies and practices, including supplier management, automation, centralization, and strategic sourcing. By nurturing robust relationships with dependable suppliers and streamlining processes through technology, businesses can optimize costs and ensure the timely availability of essential goods and services (Bienhaus & Haddud, 2018a). Moreover, embracing strategic sourcing allows organizations to consider factors beyond cost, such as supplier reliability and product quality (Ilyas, Banaras, Javaid, & Rahman, 2023; Shahid et al., 2022). This holistic approach to procurement contributes to cost control, supply chain optimization, and, ultimately, heightened efficiency. It is also essential for ensuring compliance, managing risks, and fostering sustainability, aligning with modern business values and practices (Thelander & Pettersson, 2021). Through continuous improvement and adopting emerging technologies, companies can stay competitive and resilient in a rapidly evolving marketplace, affirming the significance of procurement as a linchpin for business success (Marković & Mihić, 2022). However, numerous organizations in Pakistan struggle with many-sided work processes and out-of-date manual systems that consume significant capital and time (Rezaei, Pourmohammadzia, Dimitropoulos, Tavasszy, & Duinkerken, 2020).

In supply chain management (SCM), procurement plays a strategic role and contributes significantly to an organization's overall performance (Govindan, Kannan, Jørgensen, & Nielsen, 2022). Integrating several digital tools into the procurement process is a crucial stage toward reaping the advantages of an efficient procurement process because of the increased supply chain complexity it creates (Hassan, Sheikh, & Rahman, 2022; Khan, 2022; Rahman, Chaudhry, Meo, Sheikh, & Idrees, 2022). The typical approach to improving the procurement process has been to address the issues that most buyers face, such as how to size lots, choose suppliers, and simplify the intricate networks they operate. Even though these things are of significance, there is a limit to what organizations can manage without using computerized devices (Mukhtar et al., 2023; Nawaz, Rahman, Zafar, & Ghaffar, 2023; Tabassum, Rahman, Zafar, & Ghaffar, 2023). Digitalization is vital for this turn of events and is on the plan for some associations. The possibilities of an organization's global digital transformation are driven by newly developed technologies, or at least new supply chain technologies (Liu, Song, & Liu, 2023; Pirrone & Meyer, 2021). It fosters robust association between the procurement and supply chain teams and all levels of the supply base, enabling the central company to access vital information such as costs, availability of the stock, lead times, and financial and operational risks (Jahani, Sepehri, Vandchali, & Tirkolaee, 2021). Notably, P4.0 reduces transaction times by approximately 30-50 percent and significantly curbs value leakage by 50 percent, as evidenced by research (Althabatah, Yaqot, Menezes, & Kerbache, 2023). Furthermore, the growing body of environmental evidence from various regions worldwide has increased awareness of sustainable manufacturing practices (Yip, Zhou, & To, 2023). It underscores the importance of environmentally responsible approaches in modern procurement and supply chain management (Liu et al., 2023). The development of the Procurement 4.0 procedure, described by incorporating technology, innovations, and information driven direction, offers a promising road to support in enhancing the efficiency, transparency and the procurement performance within the bucket of managing the sustainable supply chain.

The primary objective of this examination is to analyze the perplexing relationship among the IV and DV like, Procurement 4.0 (P4.0), Sustainable Supply Chain Performance (SSCP), and the Procurement Process Optimization (PPO) within the context of sustainable supply chain management . Specifically, this research aims to achieve the following objectives:

1. The essential goal is to conclude the level of Procurement 4.0 reception and its impact on the general execution of a sustainable supply network.

2. Assessing the mediating effect of procurement process optimization (PPO is between Procurement 4.0, including strategy, planning, and performance of Procurement 4.0 and Sustainable Supply Chain Performance (SSCP)
3. In particular, we expect to research how Procurement 4.0 practices impact sustainable supply chain performance , and emphasizing the mediating role of Procurement Process Optimization (PPO) .

To navigate this uncharted territory, our research raises the following essential research questions:

1. What is the extent of the relationship between Procurement 4.0 Strategy and Procurement Process Optimization in the context of sustainable supply chain performance?
2. To what degree does Procurement 4.0 Performance Review impacts Procurement Process Optimization and, subsequently, contribute to improvements in sustainable supply chain performance?
3. How does the strategic implementation of Procurement 4.0 Planning influence Procurement Process Optimization and what is the resultant impact on sustainable supply chain performance?
4. To what extent does Procurement Process Optimization mediate the relationship between the combined effects of PS 4.0, PPR, and PP, and the enhancement of SSCP?
5. To what extent does Procurement 4.0 influence SSCP?
6. Is Procurement Process Optimization (PPO) a mediating factor in the relationship between Procurement 4.0 and Sustainable Supply Chain Performance (SSCP)?

In the unique context of Pakistan's Food Manufacturing Industry, our research delves into the pressing challenges related to sustainable supply chain performance. These challenges encompass inefficient procurement procedures, opacity in operations, suboptimal supplier management, and a need for more insights into supply chain activities. These issues are not only driving food wastage and escalating costs but are also perpetuating adverse environmental and social repercussions. The potential remedy to these predicaments lies in implementing Procurement 4.0 within the Pakistani food industry, holding the promise of enhancing sustainable supply chain performance. Nevertheless, scant research has explored the implementation of Procurement 4.0 in this specific context and, more importantly, the unique challenges and opportunities that may surface. This research is a pivotal endeavor, for it establishes a crucial link between Procurement 4.0 processes and sustainable supply chain performance within the Pakistani food industry. This research comprehensively explains how organizations can leverage Procurement 4.0 practices, potentially mediated by Procurement Process Optimization (PPO), to enhance their Sustainable Supply Chain Performance (SSCP)." The problem statement establishes the direction to assess the complex relationships between Procurement 4.0, and Sustainable Supply Chain Performance, Procurement Process Optimization. This study will assist enterprises with understanding how to make collaboration between procurement practices and sustainability objectives while underscoring the job of the optimization of the procurement processes.

2. Literature Review

In this part, it is about Procurement 4.0 and its cycles and the Sustainable Supply Chain Performance to foster a typical comprehension of how these subjects are connected.

2.1. Procurement 4.0

Primarily, Procurement 1.0 supported manual and reactive elementary relational functions. (Guarnieri & Gomes, 2019). It was about functional Procurement, overseeing everyday exercises in Procurement, and meeting the business prerequisites day to day. Procurement 1.0 was likewise named the Strategic Stage and association called Procurement 1.0. In order to meet the business's initial transactional needs, this stage introduces an early form of procurement. Procurement management was a supporting function in this stage, focusing on buying goods or services at the lowest possible cost and maintaining the cost at a minimum level. This traditional approach focused on managing transactional tasks, daily business requests, and RFXs[1]. Over the period, the business requirements and competitive

[1]RFXs = Request for information, Request for qualification, request for proposal

market shifted the need of the business to identify the possible strategies for predicting the potential business risk, innovation, and global perspectives. The role of Procurement has evolved to commit to delivering these values through technology, innovation, and collaborative supply network and planning. This advancement is known as Procurement 2.0, where businesses started to apply more noteworthy command over data progression past fundamental instructive apparatuses (Allal-Chérif, Simón-Moya, & Ballester, 2021). Category management, a cross-functional approach, and supplier relationship management are now the primary areas of emphasis in Procurement 2.0 (Malacina et al., 2022). These improvements mark a massive shift from the past cycle of Procurement 1.0. Procurement 2.0 revolved around developing services within an integrated framework of diverse processes. Procurement 2.0 is not exclusively centered around cost decrease. Rather, it takes on a vital, comprehensive methodology that envelops different elements of value creation and risk management in the current complex business landscape and interrelated global supply chain (Mavidis & Folinas, 2022).

The Industrial Revolution directed all businesses to focus on supply chain optimization, considering improving the process and increasing effectiveness while progressing in the overall performance of a supply chain to deliver the correct value to the customer and maintain the competitive edge. It includes different procedures, approaches, and advancements to improve the business's supply side (Delke, Schiele, & Buchholz, 2023). The primary objectives of supply-side optimization are cost reduction, product quality enhancement, customer satisfaction enhancement, and gaining a competitive advantage. Procurement 3.0 is all about supply chain optimization and the advanced technological shape of Procurement 2.0 (Althabatah, Yaqot, et al., 2023). Procurement 3.0 reflects significant modifications in procurement structure and shifted outlook to cloud-based technology. In this stage, the business strategy has been linked to the business by ensuring that suitable commercial agreements are in place with the right suppliers and that suitable goods and services are delivered (Mavidis & Folinas, 2022). With the development of Procurement 3.0, procurement becomes a business partner and utilizes the robust informational ecosystem, leading the business with data-driven decisions. Researchers Mavidis and Folinas (2022) have talked about the e-procurement venture in the public area and its outcomes in further developing admittance to data and straightforwardness in administration. In this review, they look at the difficulties and issues between procurement advances 3.0 and 4.0 and set out a guide for accomplishing new acquisitions for the executives in Industry 4.0. It lays the groundwork for AI-enabled predictive models that will advance decision-making in the future (Simões et al., 2023). A wholly developed utilization of such an innovation should be visible in the following obtainment phase, known as Procurement 4.0. Procurement 4.0 aligns with the Industry 4.0 paradigm, emphasizing augmented information through cognitive analytics and adaptive functions (Obermayer, Csizmadia, & Hargitai, 2022).

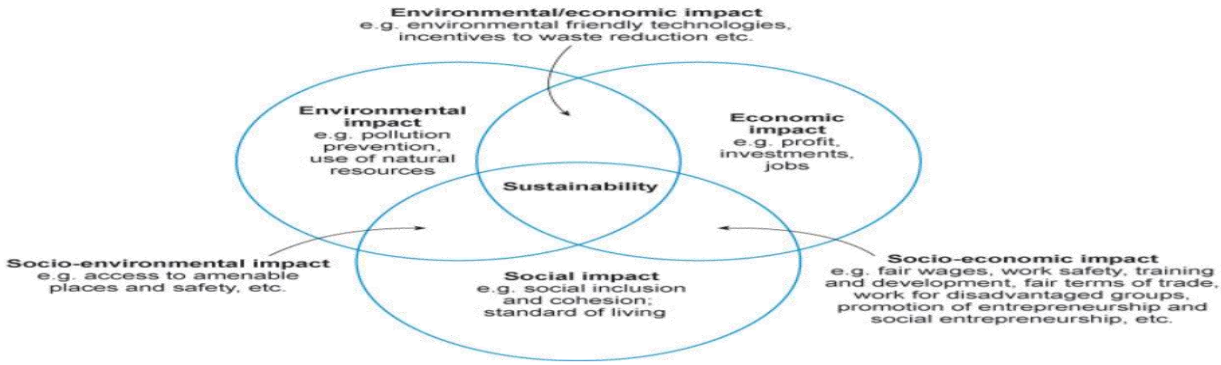
Procurement is the pivotal process for managing business relationships with suppliers, encompassing activities such as negotiations and services, as defined by (Harland, Telgen, Callender, Grimm, & Patrucco, 2019). Procurement casts its influence across various facets of business functions, ensuring the acquisition of services and items correctly, thereby facilitating the efficient progression of a company's processes and projects (Heckman, 2020). This stage represents a complex phase in producing products or processes, demanding the expertise of professionals for effective management. In its current organizational structure, the procurement trajectory is evolving to embrace Industry 4.0 capabilities (Ghadge, Kidd, Bhattacharjee, & Tiwari, 2019). Previous research indicates Huang and Handfield (2015) that organizations confronted challenges while carrying out significant business asset arranging (ERP) frameworks, and they further focused on obtaining and overseeing provider connections to execute ERP frameworks effectively. Huang and Handfield (2015) proposed two critical considerations. Regardless, ERP systems can engage in ceaseless sharing and compromise business abilities. Second, organizations might profit from utilizing a similar arrangement of pointers while executing acquisition 4.0 frameworks. Procurement 4.0 framework advancement is not generally a simple assignment. A rundown of impediments thwarting the improvement of Procurement 4.0 frameworks was given by (Bienhaus & Haddud, 2018a). They proposed that the bottlenecks could be killed by focusing on techniques, limits, and capacity. Thus, Procurement 4.0 needs to be more considered in the current writing, albeit the acquirement capability is significant to makers

2.2. Sustainable Supply Chain Performance (SSCP)

In the simplest terms, we will define the Supply Chain as an activity to convert the raw material into a saleable shape and deliver it to consumers for consumption. It covers the entire cycle from the production stage to distribution and is delivered to retailers until consumed by the end user (Elalem, Bicer, & Seifert, 2021). The supply chain process cycle' incorporates the supplier selection exercises, extensive sourcing process of the raw materials, internal and external stakeholders' collaboration, and management decisions. Its fundamental approach is to deliver quality products to consumers at competitive pricing. Further, the supply chain emphasizes reducing manufacturing costs through different productivity initiatives and value chains (Srhir, Jaegler, & Montoya-Torres, 2023). Organizations should track down compelling ways of tending to different maintainability challenges at different upstream and downstream channel levels to address every individual business' issues while at the same time further developing the manageability execution of the whole production network, which makes supply chains generally intricate.

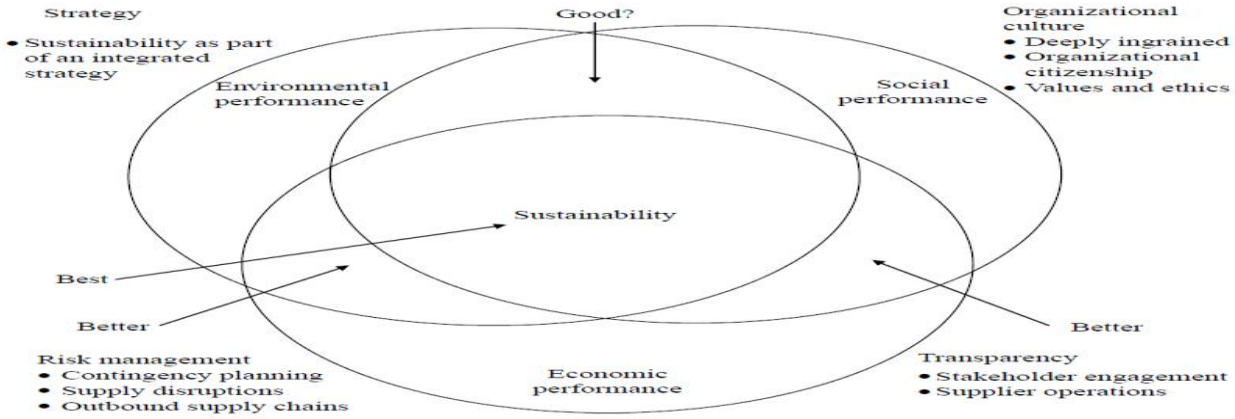
Sustainable Supply Chain Management (SSCM) integrates environmental and social practices into supply chain processes. The objective of the sustainable supply chain is to obtain sustainable sources with competitive pricing to minimize the negative impact on the environment and society (Hazaea et al., 2022). It characterizes how to deal with the progress of capital, materials, and a wide range of data connected with the SC. Organizations are reviewing sustainability in the supply chain from the perspective of the Triple Bottom Line model. They urged to develop an extensive and long-term strategy to deal with sustainability that considers the economic, social, and environmental aspects within the operations and the entire supply chain. This approach aims to create value not only for the organization but also for the environment and society as a whole. The TBL framework helps evaluate an organization's productivity in light of three economic, environmental, and social dimensions. It underscores that organizations should quantify achievement not just by monetary benefits but also by their effect on the people and planet.

Figure 1: The three impact components of sustainability and their interconnections



Because there aren't enough natural resources, the sustainability agenda is gradually evolving in the business community. The major contributor to sustainability is Business Operations, and further, these operations are led by the Supply Chain and Procurement department (Ben-Daya, Hassini, & Bahroun, 2019; Ghadimi, Wang, & Lim, 2019). Here, the synergize between the supply chain and procurement is important, as the integration of the supply chain within the organization and collaborating with the internal stakeholders is key element, whereas the procurement is bridging the goals with the external stakeholders and creating collaboration through the best available resources (Ghadimi et al., 2019; Srai & Lorentz, 2019). According to Chari et al. (2022), participating in sustainability, specifically SSCM, is not optional but instead required. SSCM helps managers answer, " What are the steps we need to take not only to survive but also to thrive—not just in one year, three years, or five years, but also in ten years, twenty years, and beyond?" SSCM involves the long-term improvement of an organization's economic bottom line. Once more, this is an important idea that can help managers start taking concrete steps.

Figure 2: Sustainable Supply Chain Management



Carter and Jennings (2002); Yip et al. (2023) recognize four supporting aspects, or facilitators of SSCM, which are additionally displayed in Figure 2:

- Strategy – Comprehensively and deliberately distinguishing individual SSCM drives which line up with and support the association's general manageability methodology
- Risk management – Expecting the potential dangers by concentrating on the upstream and downstream inventory network processes.
- An organizational culture – that is profoundly imbued and incorporates hierarchical citizenship, and further incorporates high moral principles and assumptions alongside a regard for society (both inside and beyond the association) and the regular habitat;
- Transparency **–** means creating strong platform of communication and engagement with all internal and external stakeholders to ensure traceability and reflectivity in the data coming both upstream and downstream of the operation**s.**

The sustainable supply chain indicators are currently various and hard to choose for nonexclusive execution assessment. As per the literature, there are three common sustainable supply chain indicators, monitoring and executing within organizations:

2.2.1. The Economic Dimension

A crucial aspect of performance evaluation is the economic aspect. The purpose of these economic indicators is to evaluate an organization's capability. The most widely recognized financial pointers are benefit, costs, adaptability, immortality, efficiency, quality, and business (Gunasekaran, Patel, & McGaughey, 2004). Financial and non-financial indicators are two types of economic indicators. Costs and profitability are financial metrics. Benefit can survey business execution. Productivity can be estimated with markers like profit from venture (return for capital invested), return on resources (ROA), and net benefit. Supply chain performance can also be evaluated using the actual cost. In addition, cost indicators can concentrate on activities at the micro level, such as costs associated with manufacturing, operations, transportation, inventory, labor, and logistics.

2.2.2. The Environmental Dimensions

By making their operations more eco-friendly, businesses must consider their own impact on the environment. Consumption of resources, energy, emissions, and wastes make up the environmental dimension (GRI, G4). Measurements of machine, material, water, air, soil, and land resource use are required. In manufacturing and other supply chain activities, energy and money can be saved by using resources effectively. Bouchery, Ghaffari, and Jemai (2010) discussed transportation and warehouse activities' KPIs for energy consumption and greenhouse gas emissions. In the environmental dimension, one criterion is resource consumption. According to Gupta and Kumar (2013), energy usage can evaluate environmental performance by evaluating energy consumption and fuel efficiency. For sustainability, renewable energy sources are a crucial issue. Air emissions, CO2 emissions, wastewater generation, solid waste disposal, and the consumption of hazardous, harmful, or toxic materials are examples of emissions and waste. Vinodh, Arvind, and Somanaathan (2011) presented non-product output measures of environmental performance metrics. Supply

chain activities contribute to environmental problems like air emissions, water pollution, and solid waste. Energy consumption, resource consumption, emission, and waste can all be used to evaluate environmental indicators (EPA, 2007).

2.2.3. The Social Dimensions

The social aspect evaluates production network individuals (for example networks, representatives and clients) inside four principal pointers. Health and safety, employee contentment, noise pollution, and customer satisfaction (Chen, Paulraj, & Lado, 2004; Gunasekaran et al., 2004; Yeung, 2008). A measure of output is how satisfied customers are. A metric for measuring customer satisfaction is customer complaint. The time it takes for an order to be fulfilled and delivered is known as the customer response time or order cycle time. In addition, business activities are influenced by human resource management, which includes employee satisfaction. Human resources are responsible for evaluating human performance based on capabilities and labor productivity (Freeman, 2008). Employee productivity, employee training costs, and employee turnover were some of the people-related indicators proposed by (Dossi & Patelli, 2010). Moreover, Schmidberger, Bals, Hartmann, and Jahns (2009) measured performance by presenting employee net availability. Consumer loyalty, worker fulfillment, commotion contamination, and wellbeing and security are the recognized key exhibition markers for the social aspect. The social dimension of each member of the supply chain can be measured using these indicators.

In view of the recent literatures, the key indicators of SSCP[2] are "Environment, Social, and Economic, whereas these three factors are further spited into 14 distinguished monitoring points or KPIs[3]. The KPIs are

1. Economic KPIs
a. Net Profit
b. Cost of Goods Manufactured
c. Adaptability
d. Practicality
e. Productivity
f. Quality
g. Employment
2. Environment KPIs
a. Utilities Consumption
b. Resource Utilization
c. CO2, Carbon Emission, Waste
3. Social KPIs
a. Employee Fulfillment
b. Consumer Loyalty
c. Health & Safety
d. Noise Pollution

Consumers, Employees, 3rd Party Suppliers, regulatory, and community are all stakeholders of any given supply chain and have an essential impact in the formation of environment friendly ecosystem portrays the proposed reasonable markers system for all store network partners.

2.3. Theory Underpinning

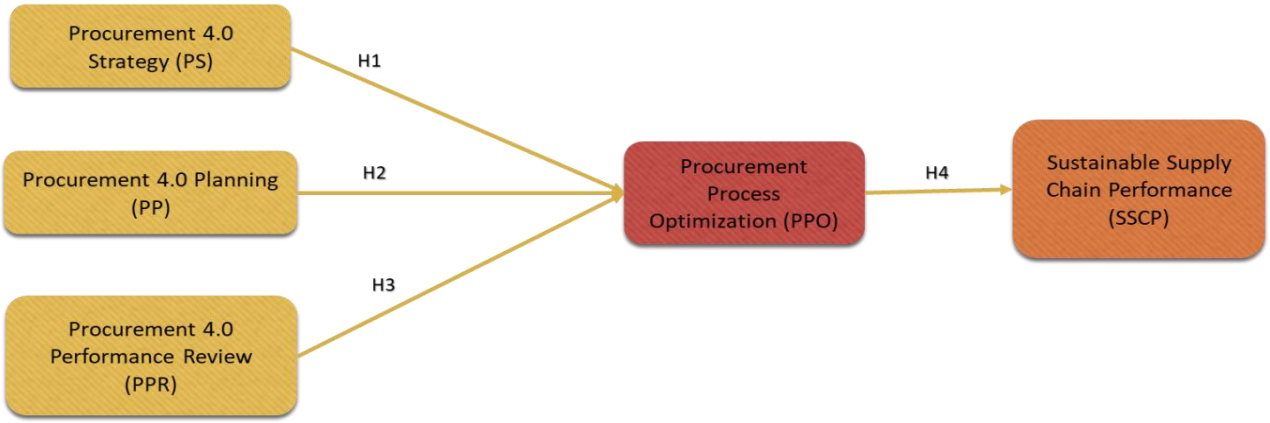
The denunciation of research community on RBV[4] prompted the advancement of dynamic capability theory. The RBV speculation considers firms including in heap of assets, and the firm can use the assets to give a high ground if the assets are one of a kind, and significant. The assortment in movement happen after some time (Barney, 1991). Notwithstanding, RBV flops in such conditions because of the continually moving business climate. The outlook of dynamic capacities D. TEECE and PISANO (1994) D. TEECE and PISANO (1994); D. J. Teece, Pisano, and Shuen (1997) has as of late arisen as the liked hypothetical structure for the researchers to make sense of vital choices in sustainability

[2] Sustainable supply chain performance
[3] Key performance indicators
[4] Resource view theory

context (Barreto, 2010). The organizational culture is always changing both internally and externally, so it is vital to respond rapidly to these progressions to try not to offend an organization's performance in overall business domain. According to voice of top management, the approach of dynamic capabilities is to deal with such circumstances and really oversee change in abnormal conditions, creating with progressive bridge of achievements (Barreto, 2010). Opportune reactions are hard to make due Easterby-Smith, Lyles, and Peteraf (2009) introduced various difficulties in regards to dynamic abilities and potential future exploration bearings, like their association with IT and other practical regions. One of the key aspects of Dynamic Capabilities Theory is that it highlights the importance of organizational learning and knowledge creation. It suggests that firms need to develop learning processes and routines to accumulate knowledge and experience, which can then be applied to sense and seize new opportunities. Additionally, the theory emphasizes the need for strategic flexibility and the ability to make timely decisions and adjust the firm's resource base to align with changing market conditions.

2.4. Theoretical Framework and Hypothesis Development

Figure 3



2.4.1. Hypothesis Development

H1: There is a significant relationship between Procurement 4.0 Strategy and Procurement Process Optimization .

H2: There is a significant relationship between Procurement 4.0 Planning and Procurement Process Optimization .

H3: There is a significant relationship between Procurement 4.0 Performance Review and Procurement Process Optimization .

H4: The combination of PS 4.0, PPR, and PP collectively influences an improvement in PPO.

H5: PPO mediates the relationship between the combined effects of PS 4.0, PPR, and PP, and the enhancement of SSCP.

2.4.2. Procurement 4.0 Strategy and the Procurement Process Optimization

PS relies upon the idea of assembling activities and size of business. Nonetheless, the rising degree of interest impact such choices over the supply chain network, making a requirement for data handling prerequisites. The fourth modern insurgency has brought forth Procurement 4.0, where every one of the capabilities are coordinated to empower a consistent progression of data. The fundamental accentuation in I4.0 is digitalization utilizing IoT, large information, and man-made consciousness (Zhou, Chong, & Ngai, 2015). PS in the feasible production network includes serious procedure and organization technique for remanufacturing and reusing material. Provider advancement methodologies and overseeing seller inventories for re-appropriating choices are key for the greatness of remanufacturing activities in maintainable store network. Embracing the right PS will lessen supply vulnerability and guarantee opportune client conveyances to every one of the plants. Nonetheless, remanufacturing may experience because of vulnerability about the opposite progression of items as far as the nature of each at the time they will be gotten. Procurement 4.0 empowered innovations can be helpful to take care of convenient data and advance acquisition process. Notwithstanding, It depends on the business and activities procedure of the firm, which might additionally impact the expectation to upgrade the Procurement interaction. The requirement for close and continuous data for improved supply line perceivability in

remanufacturing activities calls for cooperative PS which will additionally set off purchaser and providers' aim to upgrade the Procurement cycle (Srai & Lorentz, 2019). Nonetheless, It is in a supportable climate, molded by savvy production line task qualities in remanufacturing tasks that will decide the shrewd processing plant task-Procurement 4.0 innovation fit. Such an essential fit built up with constant instruction and preparing, expecting to overhaul ranges of abilities will have an impact on the disposition and mentality of purchasers/providers and improve apparent straightforwardness and handiness for application purposes (Bienhaus & Haddud, 2018a). Accordingly, we contend that the essential administration of the acquisition capability under SSCP increments viability through the structure of cooperative connections (Kusiak, 2019; Majeed & Rupasinghe, 2017; Moeuf, Pellerin, Lamouri, Tamayo-Giraldo, & Barbaray, 2018). Therefore, we hypothesize:

H1. There is a significant relationship between Procurement 4.0 Strategy and Procurement Process Optimization.

2.4.3. Procurement 4.0 Planning and the Procurement Process Optimization

The aggregate supply planning is followed by the, 1)- master production plan, 2)- aggregate production planning, 3)- material requirement planning and all these planning are synergize with some processes, defined by the supply chain department and such planning meeting are executing on different intervals basis. From procurement prospects, the material requirement from material planning is the key output for a buying representative who is doing sourcing decision accordingly (Bag et al., 2021). The capacity planning and inventory management is considered during planning for material requirement based on the production plan. Advancement of the procurement cycle in SSCP includes the streamlining of resources and expects to improve the life span of the resource through closed-loop monitoring. Improvement of the procurement cycle can be accomplished by replacing the manual cycle with I4.0[5], which will bring down the cycle time of procurement process. Notwithstanding, expectation to improve the procurement cycle time might be subject to the idea of holding inventory, stock levels, carrying cost and other warehousing factors. Nonetheless, the goal to enhance the buying interaction might be subject to the idea of the requirement to source the materials (Johne & Wallenburg, 2021). As expressed before, procurement planning is impacted by numerous elements, and the management support and key objectives are one of the key variables affecting arranging exercises. In short, the procurement planning is the short to medium to long terms strategic planning and decision making to 1)- minimize material supply risk, 2)- controlling cash flow, 3)- avoiding over stock and write-offs, 4)- meeting the consumer demands (Srhir et al., 2023; Virolainen, 1998). Hand-on procurement planning activated through I4.0 can help with quality independent direction. Unstructured information gathered through remote sensors can give significant data. I4.0 innovations can be taken advantage of to empower the presentation of data progressively utilizing a dashboard. Procurement 4.0 arranging will further develop the arranging system altogether as acquisition supervisors have total vigilance of how much the two supplies (upstream) and request (downstream) over the production network. Brilliant obtainment task-I4.0 innovation fit is the essential test in shrewd manufacturing plants (Vickery, Jayaram, Droge, & Calantone, 2003). We therefore hypothesize:

H2. There is a significant relationship between Procurement 4.0 Planning and Procurement Process Optimization.

2.4.4. Procurement 4.0 Performance Review and the procurement process optimization

Now-e-days, the supply network has expanded and converted into global village and the effective time management is the key in making the supply momentum, not only to sustain production pace but also achieving success in remanufacturing and recycling activities. Procurement 4.0 performance review can be guided on an everyday or week by week premise, while such scheduling forever be chosen in light of business nature and size. In order to monitor and discuss the overall performance of procurement, businesses are holding review meetings. In these meetings, supply criticalities can also be examined to make substitute plans (Glas & Kleemann, 2016; Schiele, 2007). Such reviews led to drive the SOIP[6] and take

[5] Industry 4.0
[6] Sales and Operation Integrated Planning

informed decision to sustain production pace, fulfilling sales orders, and minimizing wastages to ensure sustainability targets. The Processes are linked with the business domains and any loopholes may create hindrance within the whole supply chain (Fatorachian & Kazemi, 2020). In this way, procurement reviews significantly affects consumer loyalty levels in remanufacturing and reusing business. Procurement 4.0 Performance Review can be utilized as an instrument to establish a momentum both backward and forward approach and emphasize suppliers and buyers to optimize their business processes and reduce cycle time and lift the sustainability goals along with the organization (Glas & Kleemann, 2016). Consequently, we contend that Procurement 4.0 execution survey guides the purchaser's expectation to advance the acquisition cycle under the SSCP business climate, and we hypothesize that:

H3. There is a significant relationship between Procurement 4.0 Performance Review and Procurement Process Optimization.

2.4.5. Mediating Role of Procurement Process Optimization (PPO)

The aim to streamline the procurement cycle will impact ways of behaving and further encourage purchasers to improve remanufacturing and reusing tasks execution by zeroing in on boundaries, for example, improving yield rate, eliminate the waste element in resource utilization, minimize process wastes. Imaginative perspectives and convictions in the supportable development way will make a better society. Related knowledge and information on streamlining devices can change the discernment toward apparatus application. Seen simplicity and handiness of streamlining apparatuses can change mentalities towards device application, in actuality, situations and further develop SSCP execution (Bienhaus & Haddud, 2018a; Cegielski, Jones-Farmer, Wu, & Hazen, 2012; Del Giudice, 2016). The strategy that businesses use to align their procurement procedures with the goals of Industry 4.0 is referred to as the Procurement 4.0 Strategy. This may entail adopting new technologies, strengthening relationships with suppliers, and improving procurement decision-making. Resource allocation and procurement procedures can influence by a clearly defined procurement strategy to support sustainability objectives. Data-driven methods are used in the Procurement 4.0 Performance Review to evaluate and enhance procurement process outcomes (Marković & Mihić, 2022). A good performance review can show where sustainability can be improved, like reducing waste, making the most of resources, or choosing suppliers who are better for the environment. Inside the Procurement 4.0 system, Procurement 4.0 planning centers around the essential plan and execution of procurement processes (Bag, Wood, Mangla, & Luthra, 2020). The choice of vendors, material planning, transportation, and different parts of practical store supply scheduling may all affect the sustainability element in supply chain management. Furthermore, the deliberate improvement of procurement process to expand their adequacy and effectiveness is alluded to as "advancement in Procurement Process" Smoothing out work processes, decreasing postponements, and further developing obtainment execution are instances of this enhancement (Bag et al., 2021). Presently, the speculation proposes that Acquisition Interaction Streamlining fills in as a go-between. This implies that businesses are better able to implement Procurement 4.0 Strategy, carry out efficient Performance Reviews, and carry out Planning activities with a focus on sustainability when they optimize their procurement processes (for example, through automation, data analytics, and process improvement) (Althabatah, Franzoi, et al., 2023). In this manner, we contend that the blend of procurement 4.0 process, procurement 4.0 performance and planning, all in all impacts a critical improvement in streamlining and improving the Procurement Cycle:

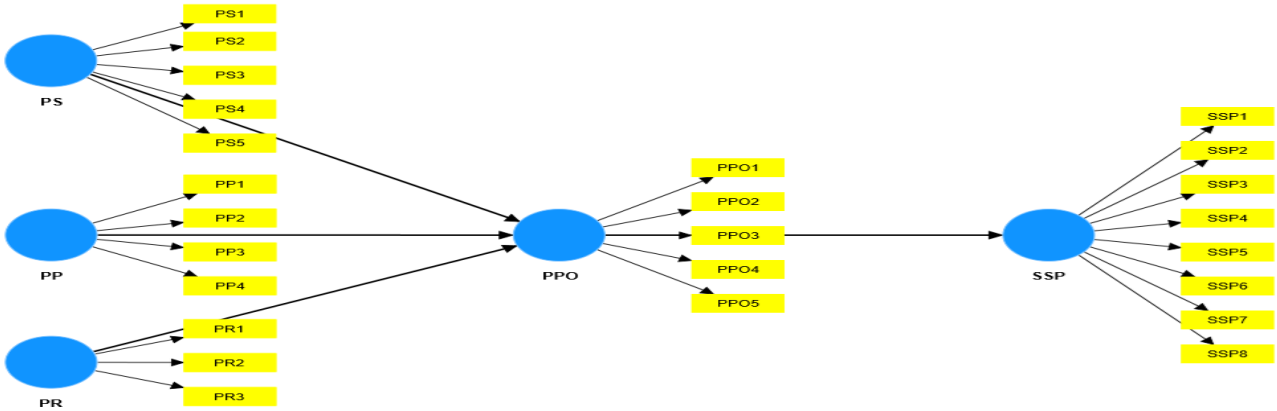
H4: The combination of PS 4.0, PPR, and PP collectively influences an improvement in PPO .
H5:Procurement Process Optimization mediates the relationship between the combined effects of Procurement 4.0 Strategy, Procurement 4.0 Performance Review, and Procurement 4.0 Planning, and the enhancement of sustainable supply chain performance.

3. Research Method

The research configuration includes inspecting from the number of leaders like officer, managers, senior managers, and GM/VP/Directors from Pakistani food industry, comprises into the 4 sub areas, 1)- frozen foods, 2)- Food & Beverages, 3)- Bakery and Confectionary, and 4)- Edible Oils and Fats. The profile of food industry is about 2500 + units in Pakistan, further split into zone like 60% in Punjab, 30% in Sindh, 10% in KPK and others

(https://pakistan.um.dk/en/the-trade-council/sectors-in-focus/food-and-agriculture - Global Harvest Initiative (GHI) (2015), Agriculture Output from TFP Growth is from USDA (2015). The data was collected through a self-administered survey from the respondents which were taken from the food industry in Pakistan. This cross-sectional study utilized convenience sampling, in which 500 questionnaires were distributed through the internet. In total, 400 questionnaires were returned of which 334 were valid. To measure the relationship in optimizing the procurement processes with the procurement strategy, procurement planning, and procurement performance and the relation between SSCP and optimizing the procurement process, the listed participants were asked to complete the survey. Because they are directly and indirectly involved in or execute the procurement function and are well aware of the challenges, the individuals and industries were selected using purposeful sampling techniques. The first part of the survey focused on questions about the Procurement 4.0 Strategy consist of five items adapted from Janda and Seshadri (2001), the Procurement 4.0 Planning consist of four items adapted from Bienhaus and Haddud (2018b); Vickery et al. (2003), the Procurement 4.0 Performance Review consist of three items adapted from and the item in this part was adapted from Bag et al. (2021); Bienhaus and Haddud (2018b); Delke et al. (2023), the Procurement Process Optimization consist of five items adopted from Bienhaus and Haddud (2018b), and the Sustainable Supply Chain Performance consist of eight items adapted from (Zailani, Jeyaraman, Vengadasan, & Premkumar, 2012). The scales with 25 measurement items were chosen to have elevated degrees of dependability and legitimacy, in light of recently distributed research. A multiple-item, 5-point Likert-type scale (1 = 'strongly disagree'; 2='disagree'; 3='neutral'; 4='agree'; 5='strongly agree') is used and such 5-point scales are commonly adopted (Tezel, Koskela, & Aziz, 2018).

Figure 4



4. Results and Discussion

This data was collected at organizational level from 400 food-manufacturing units in Pakistan and the Smart PLS 4.0 was used to test the model and outcomes of the study. Table 4.1 displays the respondents' demographics. It was essential for the study to obtain responses from individuals holding appropriate organizational positions like Procurement Officers and Managers with more than three years of experience in the field of Procurement and supply chain.

Table 1: Demographic

Demographic Variables	Categories	Frequency	Percentage
Gender	Male	245	73%
	Female	89	27%
Age	31-40	98	29%
	41-50	122	37%
	51-60	114	34%
Designation	Executive/Officer	94	28%
	Manager	113	34%
	Sr. Manager	93	28%
	GM/VP/Director	34	10%
Experience	1-5 Years	94	28%
	6-10 Years	113	34%
	11-20 Years	93	28%
	More than 20 Years	34	10%

Food Manufacturing Industry	Food & Beverages	117	35%
	Frozen Foods	71	21%
	Bakery and Confectionary	68	20%
	Edible oils and Fats	78	23%

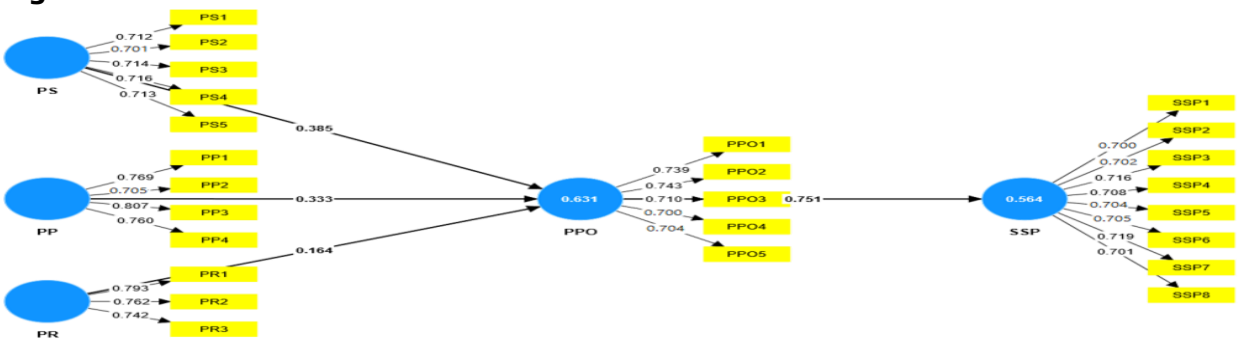
The demographics of respondents are presented in this section, as shown in Table 1. Table 1 shows that 245 (73%) were male and 89 (27%) were females. In terms of age, the 98 professionals were between 31-49, 122 professionals between the age of 41-50, and 114 professionals between the age of 51-60. In terms of professional experience, the officers, managers, senior managers, and GM/VP/Directors were 94 (28%), 113 (34%), 93 (28%), and 34 (10%) respectively. Similarly, the respondents were taken from the food manufacturing industry, further segmented 35% food & beverages, 21% frozen foods, 20% bakery and confectionary, and 23% edible oils and fats.

Table 2

Construct	Items	Loadings	Cronbach's alpha	CR	AVE
PP	PP1	0.769	0.755	0.846	0.579
	PP2	0.705			
	PP3	0.807			
	PP4	0.760			
PPO	PPO1	0.739	0.751	0.843	0.518
	PPO2	0.743			
	PPO3	0.710			
	PPO4	0.700			
	PPO5	0.704			
PPR	PR1	0.793	0.703	0.810	0.587
	PR2	0.762			
	PR3	0.742			
PS	PS1	0.712	0.756	0.837	0.506
	PS2	0.701			
	PS3	0.714			
	PS4	0.716			
	PS5	0.713			
SSP	SSP1	0.700	0.837	0.889	0.500
	SSP2	0.702			
	SSP3	0.716			
	SSP4	0.708			
	SSP5	0.704			
	SSP6	0.705			
	SSP7	0.719			
	SSP8	0.701			

Table 2 shows that the AVE value of every variable is above 0.50, the values of CR and Cronbach's alpha are above 0.70 and the value of factor loadings is above 0.60, all of which are within the accepted range. So, the conceptual model is the best fit for the hypotheses. In order to determine whether or not any indicator had been incorrectly assigned to any construct, we carried out a discriminant validity test (Kock, 2014). Using the diagonally displayed square root of average variance extracted (AVE), we examined the correlations between the latent variables. Our model meets the requirement that the AVEs be higher than the construct correlation value in order to pass this test.

Figure 5



The square roots of the AVE (average variance extracted) and the values of the correlations between the LV (latent variables) and the main diagonal of the SEM are depicted in Table 4.3. The Fornell–Larcker model's criteria 1981 were used to determine discriminant validity. In addition, all variables have the largest square root of the AVE (in bold), which falls somewhere in the range of 0.620 –0.758. As a result, the variables' discriminatory validity is maintained and validated for this approximate research model.

Table 3: Discriminant Validity - Fornell Larcker Criterion

	PP	PPO	PR	PS	SSP
PP	0.759				
PPO	0.717	0.708			
PR	0.620	0.644	0.766		
PS	0.735	0.706	0.710	0.711	
SSP	0.758	0.701	0.694	0.709	0.684

Procurement 4.0 Strategy (PP) , Procurement 4.0 Planning (PP) , Procurement 4.0 Performance Review (PR) , Procurement 4.0 Process Optimization (PPO) , and Sustainable Supply Chain Performance (SSP) Hypothesis Testing in Table 4.4, shows the results of testing the direct and indirect effect hypotheses by running Smart PLS. In the first hypothesis, we assumed a positive and significant association between, Procurement 4.0 Strategy and Procurement 4.0 Process Optimization, and this is supported in Table 4.4 (B=0.067, p = 0.0000), so we assume a positive effect of Procurement 4.0 Strategy in optimizing the procurement process. Similarly the 2nd Hypothesis is showing significant association between Procurement 4.0 Planning and Procurement Process Optimization whereas B=0.026 and p = 0.0000 ensuring that the Procurement 4.0 planning has positive effect in optimizing the procurement process. Likewise, the 3rd Hypothesis is also showing significant association between Procurement 4.0 Performance Review and Procurement Process Optimization whereas B=0.059, p= 0.0003 ensuring that the Procurement 4.0 Performance review has positive effect in optimizing the procurement process. Based on the test and rationale, we've concluded that the procurement process optimization has mediate positive effect in performance of sustainable supply chain (B=0.067, p=0.000).

The results show that the PS 4.0, PP, and PPR all improve the procurement process in a positive way. According to Tortorella and Fettermann (2018), the findings of this study are therefore comparable to those of previous studies that focused on the positive correlation that exists between the application of I4.0 and lean efforts. Audits of acquirement 4.0 can be useful; provided that managers always have access to relevant data. When businesses make sufficient investments in hardware, software, server maintenance, cyber security, and other aspects of the development of information processing capability, supply chain dashboards that reflect information in near- and real-time can assist in quality decision-making. Various issues that can be immediately settled by advancing the obtainment cycles will be raised during the audits of Acquisition 4.0. to utilize efficient enhancement based on innovation Wood, Reiners, and Srivastava (2017), this kind of decision assistance is necessary. As a consequence of this, a look at how Procurement 4.0 performed can help buyers refocus on improving procurement procedures for operational excellence. The end result suggests that sustainable supply chain performance may benefit from buyers' intentions to improve the procurement process. Utilizing both basic and advanced I4.0 tools can help reduce energy consumption, natural resource scarcity, and task completion times. One perspective that this study doesn't consider is the necessity for data handling prerequisites connected with organizations' utilization of I4.0 approaches and advances (Cegielski et al., 2012). Schroeder, Anggraeni, and Weber (2019) stressed specific manageable procedures that help with accomplishing manageability objectives.

Finally, as recently recommended Moeuf et al. (2018), the discoveries recommend that Acquisition 4.0 can drive huge advantages with the proper improvement of mature obtainment audit and procedure processes. The discoveries are critical on the grounds that they show that old, manual acquirement process steps can be supplanted with robotized ones, fundamentally diminishing process duration. Remanufacturing companies must reduce total cycle time to gain an advantage over competitors. Be that as it may, the effect of Acquisition 4.0 on lessening energy interest during the acquirement cycle can be considered in ensuing tests.

Table 4: Results of Hypothesis Testing

Hypothesis		Standard deviation (STDEV)	P values	Supported/Non Supported
H1.	There is a significant positive relationship between Procurement 4.0 Strategy and Procurement Process Optimization.	0.067	0.000	Supported
H2.	There is a significant positive relationship between Procurement 4.0 Strategy and Procurement Process Optimization.	0.026	0.000	Supported
H3.	There is a significant positive relationship between Procurement 4.0 Planning and Procurement Process Optimization.	0.059	0.003	Supported
H4	The combination of Procurement 4.0 Strategy, Procurement 4.0 Performance Review, and Procurement 4.0 Planning collectively influences a significant improvement in Procurement Process Optimization.	0.061	0.002	Supported
H5.	Procurement Process Optimization significantly mediates the relationship between the combined effects of Procurement 4.0 Strategy, Procurement 4.0 Performance Review, and Procurement 4.0 Planning, and the enhancement of sustainable supply chain performance.	0.067	0.000	Supported

4.1. Future Research Direction and Limitations

The review recognizes a few constraints that merit consideration. One critical limitation is the limited awareness on the procurement 4.0 and training of the industry participants which is the substantial challenge in setting up the supply chain model, compliant with the sustainability agenda, further monitoring its performance. Organizations, including purchasers and vendors, could require help carrying out sustainable sourcing initiatives because of different elements. These difficulties enveloped administrative and lawful intricacies, issues connected with reliable power supply, and lacks in sound digital infrastructures. Furthermore, there is an eminent requirement for additional resources and experts, with the skill to really deal with these trend-setting innovations. These specialists are expected to carry out the structure thoroughly, covering both in the reverse and forward reconciliation, and to guarantee the effective execution of the sustainable supply network. These impediments highlight the diverse idea of manageability drives in supply chains. Successful execution requests a change in mentality and preparing and requires empowering framework and a labor force with the expected range of abilities to explore the difficulties in a maintainable store network. These challenges highlight the need for comprehensive strategies to address these facets to promote sustainable supply chain management effectively.

5. Conclusion

To summarize, discussions about how to effectively incorporate sustainable practices into business strategies and operations have begun as a result of the growing significance of sustainability on both a local and global scale. Because of this goal, the Sustainable Supply Chain Management (SSCM) arises as an important strategy that empowers associations and enterprises and businesses to move from receptive methodologies, like reducing pollution and managing waste, to taking on proactive obligation across their product lifecycle. From sourcing raw materials to managing product disposal, this proactive approach is supported by a steadfast commitment to sustainability principles. The in-depth investigation of the significant impact that Procurement 4.0 and its associated processes have on enhancing sustainable supply chain performance (SSCP) is the primary impact that this research paper has. This tracking down highlights the hypothetical importance as well as the reasonable significance of

incorporating progressed obtainment rehearses into the more extensive setting of supportability. What becomes obvious from this study is that Sustainable Supply Chain Performance can possibly create significant value for the two associations and the outside climate. This worth creation appears in different ways, mostly by advancing the procurement processes at both inward and outer levels. Inside, it works with more smoothed out and efficiient. Externally, it encourages sustainable practices throughout the supply chain and fosters positive relationships with suppliers.

The role that SSCP plays in reducing the use of resources, particularly waste and materials, is one of its most notable outcomes. Through the enhancement of acquisition processes and the reception of maintainable obtaining rehearses, associations can fundamentally diminish their natural impression. Diminishing asset utilization and waste age lines up with manageability standards and adds to more productive asset usage. It positions the organization as a responsible steward of environmental resources while also cutting costs. Similarly essential is the more extensive effect of SSCP on accomplishing the 'triple primary concern,' which incorporates social, natural, and monetary execution. By coordinating maintainability into acquirement rehearses, associations can at the same time drive positive results in these three essential aspects. Socially, they can uphold neighborhood networks, advance fair work rehearses, and participate in socially mindful drives. In terms of the environment, they may be able to help mitigate resource depletion, preserve ecosystems, and reduce carbon emissions. Monetarily, they can improve functional proficiency, lessen gambles related with production network interruptions, and open up new market open doors. Eventually, the review highlights the synergistic capability of manageability and acquisition headways. A path to a business environment that is both more efficient and more responsible is provided by these two aspects. By embracing Procurement 4.0 and its reasonable standards, associations can explore the advancing requests of the market while effectively adding to the more extensive objectives of economical turn of events. It connotes a change in outlook in how organizations see and execute obtainment, recognizing its significant job in molding more economical examples.

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