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The influence of logistics and distribution processes on business process reengineering: Adopting green innovation for sustainable transformation

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The aim of this study is to investigate the influence of logistics and distribution processes on business process reengineering by adopting green innovation for sustainable transformation. Guided by the Resource-Based View (RBV), the study examines logistics and distribution processes in relation to business process reengineering (BPR), through green innovation adoption, towards achieving sustainability goals. Drawing on a conceptual framework based in supply chain management and BPR theories, the study uses Structural Equation Modeling-Partial Least Squares to analyze data collected from respondents within the target industries. The results show that streamlined logistics and distribution processes help to ensure the success of Green Innovation as part of BPR, strengthening the trend towards sustainable transformation. The study accentuates the importance of logistics management in enabling environmental stewardship and enhanced operational efficiency, providing some key ideas for improving both theoretical developments and future directions as well on practice ground to adopt sustainable supply chain trends.

1. Introduction

Today, the importance of logistics and distribution strategies in driving operational efficiency are now held as a prerequisite by today's business enterprises, especially in the context of global competition (Sterner et al., 2024). Because Logistics and Distribution Processes are very important for any organization to resemble the proposed benefits of Green Innovation, it is encouraging that these processes fulfill an edge on Business Process Reengineering (BPR) in achieving environmental transformational outcomes. (Andres et al., 2024) The companies that want to comply with the international frameworks, and enhance their operational efficiency as well compete in global market need to implement sustainable measures. Central to this transformation would be logistics and distribution (L&D), movements that are essential in any supply chain structuring, frequently shaping the strategies of organizations and outcomes they achieve overall, these core operations directly impact BPR endeavors synchronized with ecological innovation as a means for continued change within enterprises (Xu et al., 2024). In green innovation in logistics, on the other hand it is a traditional paradigm and strategic imperative of supply chain management. Through sustainable strategies, companies can reduce their ecological footprint while increasing resource efficiency and supporting global sustainability objectives. These benefits leave no doubt as to the relevance of exploring how logistics and distribution processes contribute to BPR outcomes with green innovation while Logistics and distribution processes practices are necessary for operational efficiency in supply chain management, they give even larger sustainable opportunities (Estampe et al., 2023). The ever-greater pressures on businesses to decarbonize and the move towards resource optimization, coupled with more stringent environmental legislation, have firmly positioned green innovation in logistics and distribution on a strategic footing. On the other hand, BPR is a discipline of fundamental rethinking and radical redesign of core business processes to bring about dramatic improvements in performance measures, like cost efficiency or quality. (Bi

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et al., 2024) Logistics, distribution processes, and BPR a promising area to consider how organizations might combine green innovation, as part of their initiatives, with sustainable transformation thus reinforcing operational efficiency in the process. Based on the information provided above, there are important questions as follows:

RO1: How do logistics and distribution processes impact the implementation of green innovation in organizational practices?

RO2: What are the direct and indirect effects of green innovation adoption on business process reengineering outcomes?

RO3: How can organizations leverage these insights to foster sustainable transformation effectively?

1.1 Significance of the Study

Implications for academia and industry in a nutshell This paper seeks to further academic understanding of environmental issues and business processes by combining recent developments in terms found within supply chain management, sustainability and re-engineering (Mazumder, 2015). It intends to contribute and address literature gaps by offering a systematic review of how logistics and distribution channels can be utilized as drivers for green innovation, and sustainable practices in the context of organizational environment (Judijanto et al., 2024). Essentially, the study is of great importance to organizational leaders and supply chain professionals who wish to navigate through the intricacies involved with modern business environments (Pilati & Tronconi, 2024; Wang et al., 2020). Understanding the roles of logistics and distribution processes in influencing BPR outcomes through green innovation will help businesses to strategically fit sustainability into their strategies, more gainfully reinforce operational improvements towards competitiveness as well contribute positively to environmental stewardship.

1.2 Theoretical Framework and Methodology

Theoretically, this study is rooted in sustainable supply chain management (SSCM), business process re-engineering and innovation adoption theories (Agyabeng-Mensah & Tang, 2021). The mixed-methods design blends qualitative case studies with quantitative analysis to investigate the relationships and dynamics studied in a comprehensive manner. The case studies of different industries will be analyzed to include a range in use and context, enhancing the robustness and generalization properties.

2. Literature Review and Hypotheses Development

2.1 Literature Review

2.1.1 Logistics and distribution processes

Logistics and distribution processes are the backbone of Supply Chain Management which span activities from procurement to delivery that is also essential for an organization's efficient working as well customer satisfaction (Jawabreh et al., 2023) In contrast, one of the main approaches Business Process Reengineering (BPR) consists of making essential changes by radically redesigning core business processes to develop dramatic improvements in performance (Sharabati, 2021). Therefore, sustainable logistics and distribution has recently emerged as one of the center pieces if it comes to corporate environmental mitigation due to having potential in at least reaching some SDGs (Atieh Ali et al., 2024).

2.1.2 Transportation

Transportation is an essential element in logistic and distribution activities, which has a deep impact on the business process re-engineering (BPR) as well as provides new pathways for green innovation to sustainably transform (Lahiri et al., 2022). An efficient transportation system is one of the hallmarks of critical supply chain operations, cost-cutting and overall organizational performance improvements. Companies are adopting innovations in transportation such as those related to climate change, such as electric and hybrid vehicles that allow companies to reduce environmental impacts, with special focus on reducing carbon footprints so they can comply with regulatory standards (Trivellas et al., 2020). These solutions, which conform to societal sustainability requirements and make operations more efficient as well as emissions of logistics-related environmental impact lower. Applying a sustainable transportation strategy in BPR initiatives helps to drive broader-based organizational change by reducing emissions and aiding more integrated corporate environmental stewardship, while better meeting continuously evolving market conditions and legislative requirements (Hatamlah et al., 2023). As businesses today look to focus on longer term sustainability initiatives with a dimension beyond just the environment and towards an economic edge, transportation becomes one of the key enablers.

2.1.3 Warehouse Operation

One of the critical parts of logistics and distribution operations in an organization is warehouse operations, which play a significant role to help businesses execute on time (Mohamud et al., 2023). Based on Business Process Reengineering (BPR) principles, green innovation has been adopted to optimize their operations for the better storage, handling and distribution of goods. Sustainability and efficiency will have to be reappraised at every level of these processes in the context of green innovation (Ibrahim et al., 2022). Warehouse operations revolve around maintaining inventory, keeping products available and ensuring that orders are fulfilled without a hitch (Olutimehin et al., 2024). It also benefits from the integration of technology such as Internet of Things devices which allow real-time tracking and monitoring of inventory levels, temperature conditions and equipment performance (Kembro et al., 2018). This data measurement-based method helps not just warehousing optimization but also facilitates aid in decision-making so your operation can automatically react before demand trends. The same predictive analytics can be used to both determine demand and stock levels needed, thereby reducing subsidies for overstocking caused by better use of IoT in warehouses (Abdul et al., 2020). Energy Efficient Warehousing is An Important Perspective in E-commerce and fulfilment logistics analysis. Additionally, implementation of eco-friendly packaging materials and it is respective warehousing methods to reduce waste generate opportunities for recycling (Kordos et al., 2020). This is not only beneficial for the environment but can also help in cutting down costs through waste minimization and recycling of materials where possible. Thus, the processes of logistics and distribution are projected onto warehouse operations, emphasizing their importance at last in business process re-engineering (Gray et al., 1992). By embracing environmental innovation through technology and sustainable business models, green sustainability needs to transition from the fringe.

2.1.4 Distribution Processes

Distribution processes are the mother of logistics; it drives BPR programs for green innovation and long-term sustainability (Pilati & Tronconi, 2024). Reception of goods at the right time ensures timely delivery and that too while saving on a fixed budget or without taking any lead time impediments. Distribution solutions further, and environmentally friendly enable companies to diminish their environmental impact and save handsomely (Andres et al., 2024). Additionally, it dovetails with global sustainability's top priorities and specific environmentally supporting programs that organizations are required to comply with because of stricter environmental regulations (Kmiecik, 2024). Furthermore, partnering with sustainable distribution acts and BPR projects can enhance organizational adaptability and robustness in a competitive setting that respects ecological preservation. The fad of distribution processes is now more formidable than ever for enterprises concerned with extensive international supply chains and customers levelling expectations of manufacturers and sellers to record a high note in environmental sustainability (Problems et al., 2024).

2.1.5 Green Innovation

Driver practice during BPR is green logistics and distribution process innovation where green practices and technologies integrated into logistics & distribution assist organizations with an environment-friendly operation, thus limiting the Carbon footprints along with enhancing operational efficiency (Niu et al., 2024). Green technology includes renewable alternatives to produce energy, more efficient materials and technologies that would consume less. By doing that, the same practices also yield financial returns in future savings capital costs approved investments and a brand name cash can be reinvested (Chang et al., 2024). The green innovations, which replace normal technologies with more sustainable practices can moreover contribute to furthering the aims of BPR by improving efficiency and resilience at all stages across supply chains that drive improved operational performance via superior risk management effectiveness and greater customer satisfaction. (Asad et al., 2023) Green innovation is labelled as a foundation which is useful for resource efficiency in combination with shifts to sustenance that contribute promotion of regulatory green growth and commercialization.

2.1.6 Business Process Reengineering

For sustainability purposes, green innovation is a necessary part of the Business Process Reengineering (BPR) strategy in any logistics and distribution process solution ecosystem. BPR in logistics & distribution aims at the long-term sustainability of the process with the ability to leverage modern technology, hence improving overall operational efficiency and cost reduction. & service levels too (Hamid Mohammed & Jasim Mohammed, 2024). Moreover, integrating this the best part is delivering compliance to environmental regulations & society's perceived as well drives a culture of continuous improvement, and innovation (Muhammad Rifki Yohandy & Ilyas Nuryasin, 2024). The role of logistics and distribution in BPR is very massive. Examples can be through more sustainable innovations within the enterprise, like using light and energy efficient modes of transportation or bio-degradable packaging solutions as well-advanced inventory management systems which would see their carbon footprints exponentially slashed (Trends, 2024). Not only does this improve operational efficiency and reduce wastage, but these changes also serve to gradually make your operations more sustainable in the long run, giving you a competitive advantage. Efficiency enhancing distribution routes via BPR could go a long way in reducing fuel consumption and emissions that exist in conjunction with environmentally friendly objectives (Popoola et al., 2024). In addition, by allowing organizations to rethink and redesign processes effectively, BPR facilitates greening logistics. Its end-to-end approach ensures that sustainability becomes an integral feature of the supply chain at every stage, right from procurement and continuing all along up to delivery (Yin & Zhao, 2024). The BPR approach is holistic, and it's widely believed that green processes are better integrated with brown innovation, meaning all the gears in an organization work together; this makes performance both fast and aesthetically very pretty on paper to create a more sustainable transformation (Wasfi Al-Hattab & Khashman, 2023). In the end, BPR acts as a stepping stone for companies to move forward in green innovation and make real change across their logistics & distribution networks. With sustainability aligned at the fore through BPR, businesses will be able to see long-term environmental and economic rewards while establishing themselves as frontrunners in a shift towards an eco-friendly sustainable future (Petrova et al., 2024). This innovation focuses on reengineering processes, beyond just improving operational efficiencies will ensure constant compliance with changing regulatory norms and also address the ever-rising needs of corporate environment responsibility.

2.1.7 Theoretical Frameworks

The role of the resource-based view (RBV) lies in distinguishing and managing internal resources and supports firms to gain a competitive advantage, which has significant implications on logistics deployment and businesses that identify these assets and focus on them can reengineer their business processes to match the principles of green innovation (Chae et al., 2014). Through sustainable supply chain practices, investment in green technologies and the different processes of a logistics operation can change it with more savings and make it greener, in addition, the RBV can be used strategically in sustainable transformation in logistics and distribution (Khan et al., 2023). It is in the combination of these frameworks that a solid background for coping with sustainable practices and integrating green logistic innovation principles, not only as part of an organizational strategy but also in terms of how sustainability performance can be improved through both strategic initiatives leads to increased effectiveness continuously promoting a culture combining environmental consciousness with innovative step-changes towards higher competitive advantage.

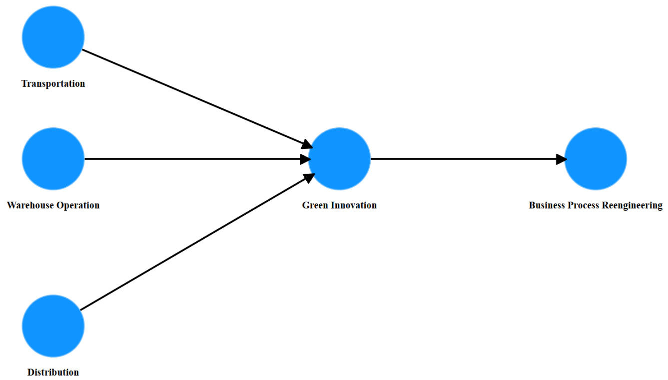

Fig. 1. Research Model

2.2 Hypotheses Development

Hypotheses based on the exploration of literature: We build upon these mere insights to test our relationships between logistics and distribution Processes, green innovation adoption which leads towards Business Process Reengineering outcomes.

2.2.1 The relationship between Logistics and Distribution Processes with Green Innovation

In this study, we focused on investigating relationships between logistics and distribution processes to green innovation which is the core area under study (Gray et al., 1992). More sustainable logistics and distribution can truly help organizations reduce their environmental footprint, save on costs if any dependency reduction, and lower carbon emissions from other green innovations such as eco-friendly packaging; and energy-efficient transportation which could further be improved by using routing optimizer. Moreover, the Integration of Green innovation in logistics and distribution processes also endows sustainable transformation that benefits ecological stewardship as well as synergy to the strategic goals of business process reengineering for long-lasting organizational success. Based on the above discussion, we propose the following hypothesis:

H_1: *Transportation positively influences the adoption of green innovation, which in turn positively impacts business process reengineering within organizations.*

H_2: *Warehouse operations positively influence the adoption of green innovation, which in turn positively impacts business process reengineering within organizations.*

H_3: *Distribution Processes positively influence the adoption of green innovation within organizations.*

2.2.2 The relationship between Green Innovation with Business Process Reengineering

Green innovation is symbiotic with BPR and transactional, transforming organizations towards growth sustainability while enhancing overall efficiency. Green technology refers to the application of environmentally friendly technologies and practices, which are said to reduce waste and help conservation efforts. When combined with BPR, these improvements result in the re-engineering of business processes to be more environmentally friendly and cost-effective. From production to logistics, incentives for businesses can completely flip through the adoption of renewable energy sources and optimized usage of resources (Ahakwa et al., 2024). Green innovation promotes the culture of continuous improvement and adaptability core principles of BPR. Incorporating sustainability into the reengineering can give businesses a competitive edge that helps secure their futures and build resilience as these markets shift quickly. Based on these considerations, the following hypothesis can be formulated:

H$_4$: *Green innovation positively impacts business process reengineering within organizations.*

2.2.3 The relationship between Logistics and Distribution Processes with Business Process Reengineering

There is an integration between logistics and distribution processes & business process reengineering (BPR) in all cases to achieve operational excellence within the supply chain network for competitive advantage. (Saad et al., 2024) Logistics and distribution are essential functions of the supply chain, which control efficient goods movement placing them from one point to another, Reengineering the processes will enhance workflows, routes and technology with better coordination among several elements of the supply chain. Logistics and distribution BPR aim to do work such as reduce lead times, cut costs, and increase delivery performance & customer satisfaction (Chidera Victoria Ibeh et al., 2024). This turn provides organizations with a more agile and adaptable supply chain capable of responding proactively to changes within the market while meeting new customer requirements, ultimately underpinning long-term growth and profitability. However, logistics reengineering will benefit from more advanced technologies such as IoT devices to provide real-time data for better decision-making. Based on these insights. we have formulated the following hypothesis:

H$_5$: *Optimized distribution processes positively influence the adoption of green innovation within organizations.*

H$_6$: *Efficient transportation systems positively influence the adoption of green innovation within organizations.*

H$_7$: *Effective warehouse operations positively influence the adoption of green innovation within organizations.*

3. Methodological Approach

This research investigates how far green innovation has developed from the implementation of logistics and distribution processes to a business process reengineering (BPR) level, through sustainable transformation (S. A. Khan et al., 2024). This existing research applies the Smart PLS 4, a robust SEM analysis tool that permits us to handle intricate causal relationships and test measurement models. Surveys collected data from the logistics, distribution and BPR professions during which experiences with green innovation are questioned. The survey gauged how sustainable practices improve organizational sustainability and efficiency (Hatamlah et al., 2023). The measurement model was assessed by statistical analysis with Smart PLS 4 to validate the reliability and validity of all concepts, aiming to evaluate how green innovations affect logistics, distribution, and BPR outcomes.

3.1 Questionnaire Development and Validation

The questionnaire development for this study was guided by a comprehensive literature review and theories on logistics, distribution processes, business process reengineering and green innovation. Content validity was established via a review of the questionnaire by five experts with experience in supply chain sustainability and research content. A pilot survey was used to test the developed questionnaire via a selected 170 sample persons working in Almarai Company, Saudi Arabia belonging to the manufacturing sector and having similar organizational backgrounds. The purpose of the pilot study was to assess the clarity and understandability of questionnaire items. The results of the pilot were analyzed, and amendments were made to the questionnaire on how questions can be better understood by respondents correctly.

3.2 Sampling Technique

The participants were selected from Almarai Company in Saudi Arabia from the dairy sector, via convenience sampling. This method was selected due to being able to reach professionals involved in the logistics & distribution and business process reengineering activities within this particular industry. Nevertheless, the study results were interpreted in light of potential biases.

3.3 Data Collection Process

The survey was conducted on a targeted sample of 170 professionals who work in Almarai Company, Saudi Arabia and belong to the dairy sector using Google Forms. The study goals were presented, and their participation was preceded by signing a consent statement. Additional reminders were sent in two waves, to improve response rates and participation with a careful check-up at every stage ensuring the completeness of collected data as well as its representativeness.

3.4 Analysis Technique: Partial Least Squares Structural Equation Modeling (PLS-SEM)

Smart PLS-4 has been chosen for this study because it is an exploratory research design, which requires flexibility and allows complex models to be reasonably resolved (Hair et al., 2019). This method will allow the examination of a myriad number of variables, including all direct and mediated effects within the conceptual framework. When performing PLS-SEM analysis, the same model specification was applied by defining latent constructs such as green innovation adoption and logistics efficiency based on a theoretical ground. These constructs have typically been evaluated with measurements of composite reliability and Cronbach's alpha reliability as well as tests for convergent and discriminant validity.

3.5 Limitations and Mitigation Strategies

Limitations include self-reported data only, possibly biased results because of convenient sampling and the cross-sectional design used to collect this study. Mitigation strategies included rigorous validation of questionnaire items, transparency in reporting methodology, and sensitivity analyses to address potential biases. Participants' demographic data provided insights into the profile of respondents, including those from Almarai Company in Saudi Arabia within the dairy sector.

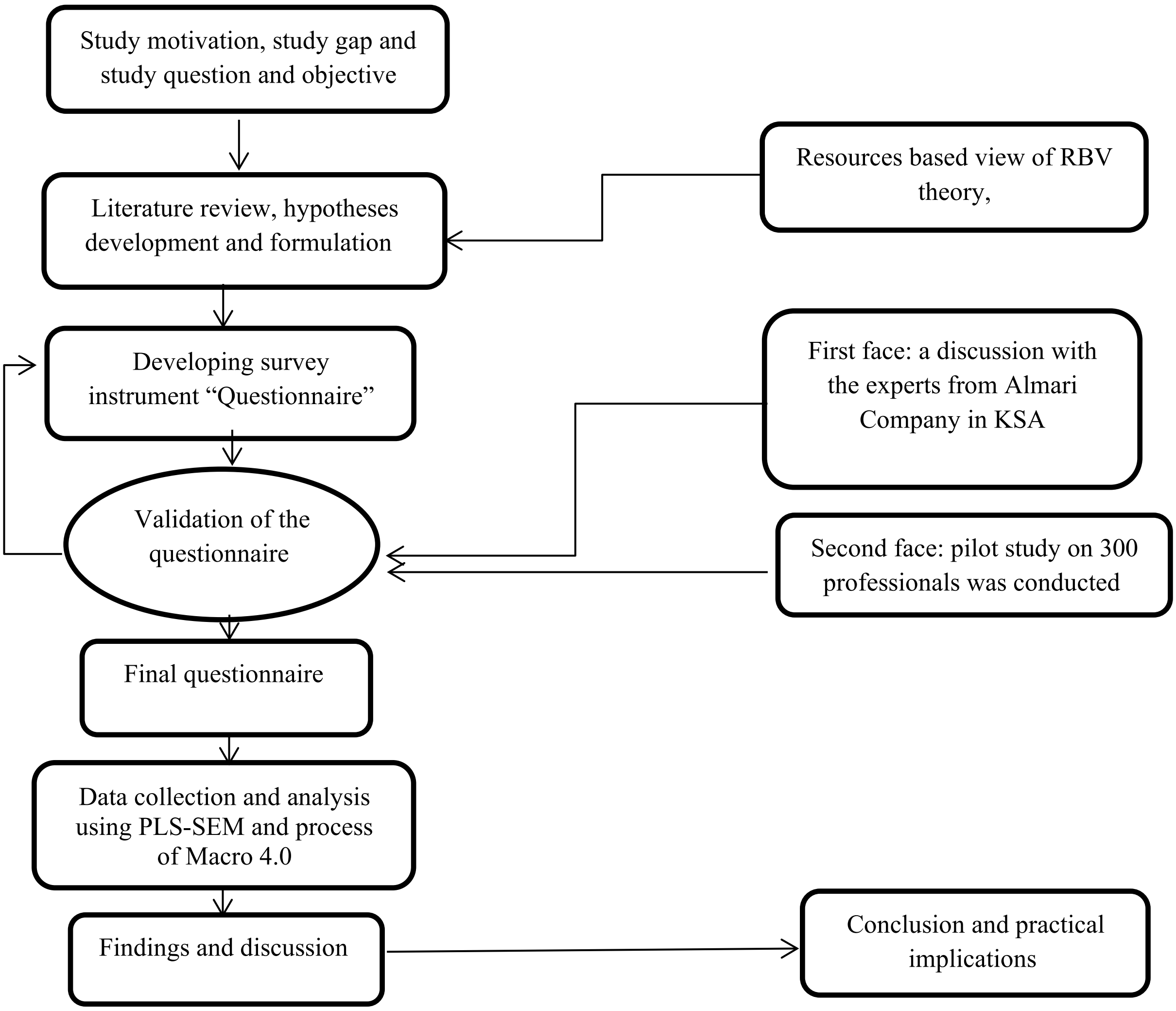

Fig. 2. Research framework

3.6 Data analysis

Data analysis employed PLS-SEM to rigorously examine and uncover the intricate relationships among logistics efficiency, green innovation adoption, and business process reengineering outcomes within the manufacturing sector of Almarai Company in Saudi Arabia. This method facilitated a comprehensive understanding of how sustainable practices in logistics and innovation adoption contribute to organizational efficiency and transformation. The findings offer strategic insights for enhancing operational effectiveness and sustainability in the dynamic context of manufacturing industries.

Table 1 demonstrates Strong reliability and validity for all the constructs. For the Transportation construct, the factor loadings were in the range of 0.714 to 0.84 which produced a Cronbach's alpha of 0.88, a C.R. of 0.909, and an AVE of 0.626 all represent good indicator reliability and internal consistency. The Warehouse Operation factor loadings factors have been found between 0.747 to 0.852 with the Cronbach's alpha 0.898, C.R. 0.922, and AVE 0.662 which represents very high reliability and convergent validity. The factor loadings of the Distributions Processes have been found ranging from 0.753 to 0.884, having Cronbach's alpha 0.875, C.R. 0.909, and AVE 0.667 that reveals the strong reliability and validity. The factor loadings of Green Innovation signs are between 0.796 to 0.847, the Cronbach's alpha is 0.84, the C.R. is 0.893, and the AVE is 0.676 which also indicates robust reliability and convergent validity. Interestingly, the BPR has factor loadings from 0.753 to 0.828, has Cronbach's alpha 0.89, C.R. 0.916, and AVE 0.644 which has strong internal consistency and convergent validity. It can be observed that all factor loading, Cronbach's Alpha, C. R., and AVEs are far above the acceptable value, which indicates the strength and robustness of the construct.

Table 1
Factor loadings

Constructs	Items	Factor loadings	Cronbach's Alpha	C.R.	(AVE)
Transportation	Tr1	0.806	0.88	0.909	0.626
	Tr2	0.714			
	Tr3	0.769			
	Tr4	0.84			
	Tr5	0.824			
	Tr6	0.789			
Warehouse Operation	WRh1	0.848	0.898	0.922	0.662
	WRh2	0.837			
	WRh3	0.852			
	WRh4	0.791			
	WRh5	0.802			
	WRh6	0.747			
Distribution Processes	Dip1	0.806	0.875	0.909	0.667
	Dip2	0.824			
	Dip3	0.753			
	Dip5	0.811			
	Dip6	0.884			
Green Innovation	Gi1	0.796	0.84	0.893	0.676
	Gi2	0.847			
	Gi3	0.831			
	Gi4	0.815			
Business Process Reengineering	BPR1	0.753	0.89	0.916	0.644
	BPR2	0.797			
	BPR3	0.788			
	BPR4	0.825			
	BPR5	0.823			
	BPR6	0.828			

3.7 Structural Model

Discriminant validity tests and cross-validation are commonly used methodologies to assess validity. Initially, HTMT is examined to ensure discriminant validity (Henseler, Ringle, & Sarstedt, 2015). Recent studies (Franke & Sarstedt, 2019) have refined the recommended thresholds, which are detailed in Table 2. These values fall within acceptable ranges, indicating robust identification of factor variables without overlap. These findings affirm the reliability and validity of the measurement model, underscoring its rigorous methodological approach.

Table 2
HTMT

	Audience Engagement	Marketing Agility	Sustainable Business Performance	Virtual reality (VR)
Audience Engagement				
Marketing Agility	0.777			
Sustainable Business Performance	0.735	0.72		
Virtual reality (VR)	0.847	0.754	0.825	

Table 2 shows the Heterotrait-Monotrait Ratio (HTMT) indicating discriminant validity between the constructs. The HTMT values for the Distribution Process are between 0.702 (Green Innovation) and 0.836 (Business Process Reengineering). The HTMT values of Green Innovation fall on 0.622 (Warehouse Operation) and to a high value with Business Process Reengineering: 0.799 For the Transportation construct, HTMT values range from 0.651 with Warehouse Operation to 0.839 with Business Process Reengineering The HTMT values for the construct Warehouse Operation range from 0.622 with Green Innovation to 0.772 with Distribution Process Thirdly, for the Business Process Reengineering construct with HTMT value ranging from 0.677 to Warehouse Operation and 0.839 in Transportation Table V shows that all HTMT values are lower than the threshold of 0.85, indicating acceptable discriminant validity between constructs among each other.

Table 3
Fornell-Larcker

	Distribution Process	Green Innovation	Transportation	Warehouse operation	Business Process Reengineering
Distribution Process	0.817				
Green Innovation	0.611	0.822			
Transportation	0.63	0.69	0.791		
Warehouse operation	0.688	0.548	0.588	0.814	
Business Process Reengineering	0.74	0.699	0.752	0.61	0.803

Table 3 shows discriminant validity of the constructs, Fornell-Larcker criterion where the diagonal values are the root of average variance extracted (AVE) for each construct and the off-diagonal elements symbolize correlations among constructs. Distribution Process has also AVE square root of 0.817; the lowest correlation was with Green Innovation (r = 0.611) and the highest one, Business Process Reengineering (r = 074). With the relationships varying from 0.548 with Warehouse Operation to 0.822 (AVE square root) - Green Innovation Transportation construct has an AVE root of 0.791; the correlations are between that and Warehouse Operation (0.588) to Business Process Reengineering (BPR) one at 0.752 AVE square root Firm Market Warehouse Operation followed direct to Flow 1.854 - From 0.453 with IHBIWFP of Green Innovation up into GAPSISF4: A dimension inhalation; could be static between Distribution Process Finally, Business Process Reengineering has a AVE square root of 0.803, with correlations between the factor and Warehouse Operation ranging from 0.61 to Transportation (r =.752). Fornell-Larcker criterion shows that all constructs meet the Fornell Larcker criterion as square root of AVEs are high corresponding correlations with other variables.

Table 4
R^2 Adjusted

	R-square	R-square adjusted
Green Innovation	0.503	0.533
Business Process Reengineering	0.418	0.489

Table 4 demonstrates the results of R^2 and Adjusted R^2 Green Innovation Business Process Reengineering. In general, our Adjusted R^2 0.533 is slightly higher than we could expect for this number or predictors, so the model fit seems to be good (although only by a small part above our upper border). Therefore, for Business Process Reengineering $R^2 = 0.418$ is a model that estimates this information, and the same way explains only 41.8% of our variances. Adjusted $R^2 = 0.489$; Increased explanatory power on parameter count, also model fitness is good Both the Models have a moderate estimation ability this fact is further validated through the Model's Adjusted R^2 values which states that both these models are valid for identifying correlations between Independent Variables and Green Innovation, Business Process Re-Engineering.

Table 5
Demographic information of respondents

Characteristic	Frequency	Percentage
Sector of the Health Service		
Hospitals	78	29%
Clinics	62	23%
Pharmaceuticals	46	17%
Others	62	23%
Role in Marketing and Strategy		
Marketing Manager	70	26 %
Digital Marketing Specialist	46	17%
Operations Manager	54	20 %
Sustainability Specialist	30	11 %
Other	70	23%
Education Level		
Diploma	30	20%
Bachelor's Degree	85	50%
Master's/Doctorate Degree	55	30%
Experience		
Less than 10 years	45	14 %
10-14 years	25	26 %
15-19 years	40	23 %
20-24 years	30	17 %
25+ years	30	17 %

Table 5 presents demographic information: The demographic characteristics of the participants working in logistics and distribution processes from different sectors are summarized in Table 5. The respondents come largely from manufacturing (35%), services (23%) and retail, wholesale, distribution (17%). In logistics roles, 2 26% are supply chain managers and 17% represented by both a logistics coordinator and operations manager, 11% are sustainability specialists and 23% other roles. As for education, half of them have a Bachelor, 1/3 Master or higher and a fifth Diploma. 14% of attendees have fewer than 10 years ahead of them, while 26% has between ten and fourteen more to go with the rest having from fifteen to nineteen et al. Probably as expected the light blue and purple bars are a similar distance from 25%, with those working for more than 24 years perfectly mirroring that same decline in younger respondents; about half of each group. These results show a well-diversified respondent group with jobs in industries like manufacturing, services, retail and transportation that mostly involve logistics functions along with all levels of education and experience. That title suggests that the project is seeking a comprehensive analysis of opinion on logistics and distribution-related influencers within their broad demographic range in order to comprehensively assess prospects for sustainable practice adoption.

4. Hypotheses Testing

The path coefficient, similar to the beta weight in conventional regression analysis, plays a significant role in the PLS Algorithm function within Smart PLS 4.0 for structural modeling. It indicates the strength and direction of relationships between variables, ranging from -1 to +1. Values tend to one represent a useful relationship, and values closer to 0 mean that there is almost no relation between them. To give statistical significance (having coefficient, standard error T-Value, P-value) typically ≤0.05), Alpha value is calculated. A threshold level of 0.05 is applied to evaluate the validity and reliability of path coefficients to enhance analysis, validation and understanding relationships among constructs within a significance model as shown below; in Fig. 2.

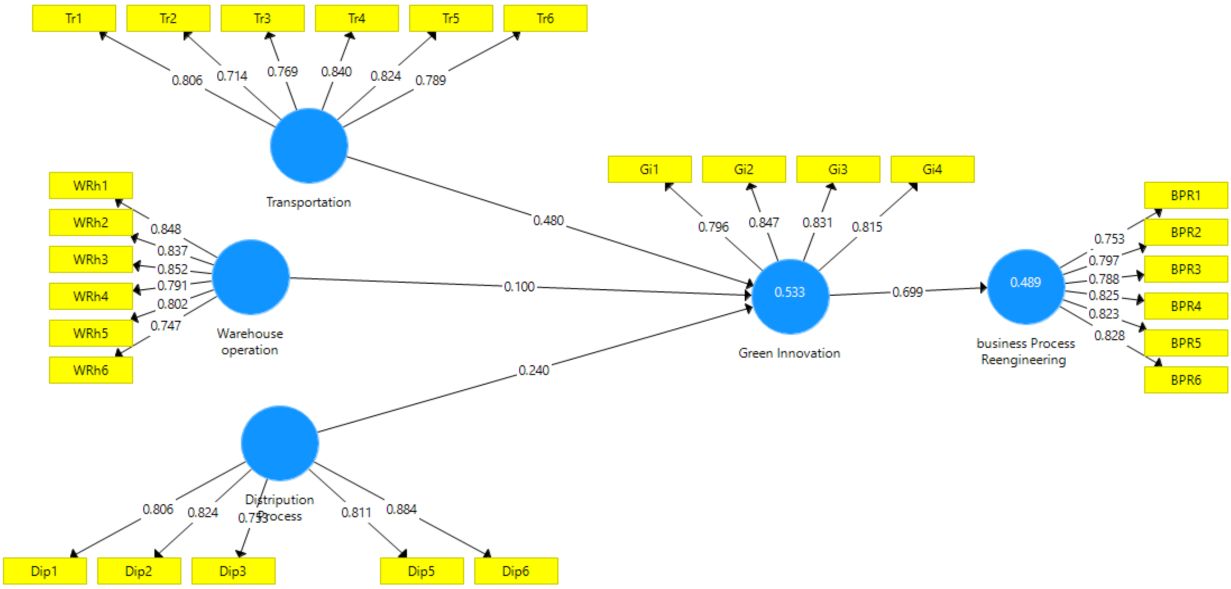

Fig. 2. Measurement Model

Table 6
Hypotheses testing estimates

H.	Relationships	Standardized Beta	Standard Error	T-Statistic	P-Values	Decision
H1	Distribution Process → Green Innovation → business Process Reengineering	0.168	0.072	2.341	0.02	Supported
H2	Transportation → Green Innovation → business Process Reengineering	0.335	0.07	4.768	0	Supported
H3	Warehouse operation → Green Innovation → business Process Reengineering	0.07	0.071	0.984	0.326	Unsupported
H4	Distribution Process → Green Innovation	0.24	0.091	2.625	0.009	Supported
H5	Green Innovation → business Process Reengineering	0.699	0.056	12.539	0	Supported
H6	Transportation → Green Innovation	0.48	0.1	4.782	0	Supported
H7	Warehouse operation → Green Innovation	0.1	0.101	0.999	0.318	Unsupported

Table 6 estimates of hypotheses testing found significant effects on the relationship between logistics and distribution processes, BPR mediated by green innovation When conducted by Green Innovation, both Distribution Processes and Transportation have significant positive relationships with BPR as indicated by low P-values (0.020; 0.000) and strong standardized coefficients (0.168; 0335). On the other hand, significantly P-values are higher (0.326 for BPR with Green Innovation and 0.318 of itself). In summary, these findings have shown that the effective working of Distribution Processes and Transportation influences organizational change through sustainable practices thereby reinforcing their role in improving operational efficiency and competitive advantage grounded on sustainability architecture.

5. Findings

The findings of this study offer valuable insight regarding the impact or significance of logistics and distribution processes towards Business Process Reengineering (BPR) when moving to sustainable transformation, particularly with the adoption of green innovation. It emphasizes the critically important links between logistics and distribution strategies. The results underline the critical relevance of successful logistics management in enabling the unproblematic incorporation of green aspects into BPR packages. The main theoretical contribution of this research to sustainable supply chain management (SSCM) is that green innovation can have a shorter economic payback, and gain higher executive support for improved logistic efficiency. This leads to practitioners in engineering, as well as other relevant disciplines like industrial management and operations research, that should practice logistics capabilities optimizations together with sustainable distribution activities were critical action plans for companies in achieving some sustainability goals while enhancing operation competence. On the other hand, this study, though faced with some limitations that may allude to sampling biases, provides an extensive look into how logistics and distribution activities can affect BPR outcomes as well as green innovation adoption in a wider perspective for other variables.

6. Managerial Implications

The managerial implications of this study provide important strategies for the administrators and supply chain managers towards improving BPR through green innovation in logistics & distribution methodologies. The results highlight the significance of logistics enhancement and a sustainable distribution policy to reinforce enterprise sustainability efficiently. Managers should focus on investing in green technology and instill an environmental stewardship mindset through exclusive policies. To achieve this, companies are advised to engage in environmental awareness training programmers for their employees as well as encourage internal trust and engagement amongst its stakeholders to increase the level of green integration within the organization, the development of big data analytics capabilities is important to be leveraged for performance improvement across a green supply chain and requires planned investments in technology infrastructure as well as employee training. Predictive modeling and customer engagements can be well advanced with incentive systems and the use of AI for better analytics to optimize the increased performance in a sustainable supply chain. The focus of the research studies is integrating logistics and distribution processes to sustain green invention at a level of organization.

7. Limitations and Future Research

This study offers many useful insights, but it does have its limitations that must be kept in mind when applying the results. Research might adopt a longitudinal data approach to capturing the temporal dynamics between green intellectual capital, and big data analytics capabilities. The study was focused only on the dairy sector of Saudi Arabia, Almarai Company therefore, some of our results may not apply to other countries or other sectors with different cultural settings. Extending this type of research into a range of models would offer an excellent source for scholars and management practitioners alike. Additionally, this study used quantitative methods with questionnaires only capturing surface-level meaning and did not include qualitative approaches like interviews to gain richer perspectives. Further research would be beneficial to develop a more detailed understanding of how different stakeholders experience and perceive green supply chain management, which may require the use of qualitative methodology. Finally, future research might investigate the mediating constructs such as green innovation and green human resource management practices in understanding how these relationships are more relevant than we observed them to be. Developing these avenues will contribute to theoretical frameworks and practical applications in sustainable supply chain management alike.

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References

Abdul, S., Khan, R., Zhang, Y., & Nathaniel, S. (2020). *LogForum*, *16*(1), 141–159.

Agyabeng-Mensah, Y., & Tang, L. (2021). The relationship among green human capital, green logistics practices, green competitiveness, social performance and financial performance. *Journal of Manufacturing Technology Management*, *32*(7), 1377–1398. https://doi.org/10.1108/JMTM-11-2020-0441

Ahakwa, I., Tackie, E. A., Tackie, F. K., Mangudhla, T., Baig, J., Islam, S. ul, & Sarpong, F. A. (2024). Greening the path to carbon neutrality in the post-COP26 era: Embracing green energy, green innovation, and green human capital. *Innovation and Green Development*, *3*(3), 100134. https://doi.org/10.1016/j.igd.2024.100134

Andres, B., Diaz-Madronero, M., Soares, A. L., & Poler, R. (2024). Enabling Technologies to Support Supply Chain Logistics 5.0. *IEEE Access*, *12*(February), 43889–43906. https://doi.org/10.1109/ACCESS.2024.3374194

Asad, M., Aledeinat, M., Majali, T., Almajali, D. A., & Shrafat, F. D. (2023). Mediating role of green innovation and moderating role of resource acquisition with firm age between green entrepreneurial orientation and performance of entrepreneurial firms. *Cogent Business and Management*, *11*(1). https://doi.org/10.1080/23311975.2023.2291850

Atieh Ali, A. A., Sharabati, A. A., Alqurashi, D. R., Shkeer, A. S., & Allahham, M. (2024). The impact of artificial intelligence and supply chain collaboration on supply chain resilience: Mediating the effects of information sharing. *Uncertain Supply Chain Management*, *12*, 1801–1812. https://doi.org/10.5267/j.uscm.2024.3.002

Bi, H., Zheng, R., & Lu, F. (2024). Risk Assessment and Countermeasures of Logistics Terminal Distribution under Public Health Emergencies. *Systems*, *12*(4), 1–17. https://doi.org/10.3390/systems12040128

Chae, B. K., Olson, D., & Sheu, C. (2014). The impact of supply chain analytics on operational performance: A resource-based view. *International Journal of Production Research*, *52*(16), 4695–4710. https://doi.org/10.1080/00207543.2013.861616

Chang, K., Luo, D., Dong, Y., & Xiong, C. (2024). The impact of green finance policy on green innovation performance: Evidence from Chinese heavily polluting enterprises. *Journal of Environmental Management*, *352*(September 2023), 119961. https://doi.org/10.1016/j.jenvman.2023.119961

Chidera Victoria Ibeh, Onyeka Franca Asuzu, Temidayo Olorunsogo, Oluwafunmi Adijat Elufioye, Ndubuisi Leonard Nduubuisi, & Andrew Ifesinachi Daraojimba. (2024). Business analytics and decision science: A review of techniques in strategic business decision making. *World Journal of Advanced Research and Reviews*, *21*(2), 1761–1769. https://doi.org/10.30574/wjarr.2024.21.2.0247

Estampe, D., Lamouri, S., Paris, J., Brahim-djelloul, S., Estampe, D., Lamouri, S., Paris, J., A, S. B., Estampe, D., Lamouri, S., Paris, J., & Brahim-djelloul, S. (2023). *A framework for analysing supply chain performance evaluation models To cite this version : HAL Id : hal-01910995 A framework for analysing supply chain performance evaluation models*.

Gray, A. E., Karmarkar, U. S., & Seidmann, A. (1992). Design and operation of an order-consolidation warehouse: Models and application. *European Journal of Operational Research*, *58*(1), 14–36. https://doi.org/10.1016/0377-2217(92)90232-X

Hamid Mohammed Ali, M., & Jasim Mohammed, N. (2024). The Impact of Business Process Reengineering on the Quality of Banking Service: An Analytical Study in Public Commercial Banks in Iraq. *Journal of Economics and Administrative Sciences*, *30*(140), 188–206. https://doi.org/10.33095/x0dy5193

Hatamlah, H., Allan, M., Abu-Alsondos, I., Shehadeh, M., & Allahham, M. (2023). The role of artificial intelligence in supply chain analytics during the pandemic. *Uncertain Supply Chain Management*, *11*(3), 1175–1186. https://doi.org/10.5267/j.uscm.2023.4.005

Ibrahim, I. D., Hamam, Y., Sadiku, E. R., Ndambuki, J. M., Kupolati, W. K., Jamiru, T., Eze, A. A., & Snyman, J. (2022). Need for Sustainable Packaging: An Overview. *Polymers*, *14*(20), 1–16. https://doi.org/10.3390/polym14204430

Jawabreh, O., Baadhem, A. M., Ali, B. J. A., Atta, A. A. B., Ali, A., Al-Hosaini, F. F., & Allahham, M. (2023). The Influence of Supply Chain Management Strategies on Organizational Performance in Hospitality Industry. *Applied Mathematics and Information Sciences*, *17*(5), 851–858. https://doi.org/10.18576/AMIS/170511

Judijanto, L., Asniar, N., Kushariyadi, Utami, E. Y., & Telaumbanua, E. (2024). Application of Integrated Logistics Networks in Improving the Efficiency of Distribution and Delivery of Goods in Indonesia a Literature Review. *Sciences Du Nord Economics and Business*, *1*(01), 1–10.

Kembro, J. H., Norrman, A., & Eriksson, E. (2018). Adapting warehouse operations and design to omni-channel logistics: A literature review and research agenda. *International Journal of Physical Distribution and Logistics Management*, *48*(9), 890–912. https://doi.org/10.1108/IJPDLM-01-2017-0052

Khan, M., Ajmal, M. M., Jabeen, F., Talwar, S., & Dhir, A. (2023). Green supply chain management in manufacturing firms: A resource-based viewpoint. *Business Strategy and the Environment*, *32*(4), 1603–1618. https://doi.org/10.1002/bse.3207

Khan, S. A., Al Shamsi, I. R., & Haider, S. Z. (2024). The Potential Impact of Blockchain Technology on Integration, Agility, and Collaboration in Supply Chain Performance is the Focus of an Empirical Study Conducted Within the Industries of Oman and Pakistan. *Kurdish Studies*, *12*(1), 748–763. https://doi.org/10.58262/ks.v12i1.047

Kmiecik, M. (2024). *Autonomization of non-added value process in logistics – case autonomization of non-added value process in logistics – case study*. *June*. https://doi.org/10.29119/1899-6116.2022.60.4

Kordos, M., Boryczko, J., Blachnik, M., & Golak, S. (2020). Optimization of warehouse operations with genetic algorithms. *Applied Sciences (Switzerland)*, *10*(14). https://doi.org/10.3390/app10144817

Lahiri, M. M., Sarkar, S., & Bhargava, M. (2022). The Role of 3rd Party Logistics In Bringing Efficiency & Effectiveness among their Distribution Centers. *Academy of Marketing Studies Journal*, *26*(6), 1–7.

Mazumder, S. (2015). Lean Wastes and its Consequences for Readymade Garments Manufacturing. *Global Journal of Researches in Engineering*, *15*(1), 15–20.

Mohamud, I. H., Abdul Kafi, M., Shahron, S. A., Zainuddin, N., & Musa, S. (2023). The Role of Warehouse Layout and Operations in Warehouse Efficiency: A Literature Review. *Journal Europeen Des Systemes Automatises*, *56*(1), 61–68. https://doi.org/10.18280/jesa.560109

Muhammad Rifki Yohandy, & Ilyas Nuryasin. (2024). Business process reengineering on room rental administration system in Malang city. *Jurnal CoSciTech (Computer Science and Information Technology)*, *5*(1), 110–118. https://doi.org/10.37859/coscitech.v5i1.6944

Niu, P., Sun, K., Sun, L., & Chang, C. W. (2024). The political economy and green innovation: A scientometric analysis. *Innovation and Green Development*, *3*(2), 100116. https://doi.org/10.1016/j.igd.2023.100116

Popoola, O. A., Adama, H. E., Okeke, C. D., & Akinoso, A. E. (2024). Cross-industry frameworks for business process reengineering: Conceptual models and practical executions. *World Journal of Advanced Research and Reviews*, *22*(1), 1198-1208. https://doi.org/10.30574/wjarr.2024.22.1.1201

Olutimehin, D. O., Ofodile, O. C., Ejibe, I., Odunaiya, O. G., & Soyombo, O. T. (2024). The Role of Technology in Supply Chain Risk Management: Innovations and Challenges in Logistics. *International Journal of Management & Entrepreneurship Research*, *6*(3), 878–889. https://doi.org/10.51594/ijmer.v6i3.941

Petrova, D., Nikolova, N., & Lengerov, A. (2024). Modeling Business Process Reengineering in the Digital Era of Industry 4.0. *AIP Conference Proceedings*, *2980*(1), 0–7. https://doi.org/10.1063/5.0185275

Pilati, F., & Tronconi, R. (2024). Tri-Objective Vehicle Routing Problem to Optimize the Distribution Process of Sustainable Local E-Commerce Platforms. *Sustainability (Switzerland)* , *16*(5). https://doi.org/10.3390/su16051810

Problems, T., International, X. V. I., & Conference, S. (2024). *Impact of digital solutions on work processes in*.

Saad, A., Zaini, Z., & Alwahaibi, Y. (2024). *Transforming Medical Assistance Fund Application Management : A Business Process Reengineering Approach*. *April*, 45–64.

Sharabati, A.-A. A. (2021). Lean Operations and Competitive Advantage in the Pharmaceutical Industry. *International Journal of Services and Operations Management*, *1*(1), 1–23. https://doi.org/10.1504/ijsom.2021.10038296

Sterner, K., Edman, T., & Fjeld, D. (2024). Transport management–a Swedish case study of organizational processes and performance. *International Journal of Forest Engineering*, *35*(1), 72–79. https://doi.org/10.1080/14942119.2023.2202614

Trends, G. S. (2024). *REENGINEERING OF BUSINESS PROCESSES OF THE PROVISION OF*. *1*, 51–61. https://doi.org/10.5281/zenodo.10635257

Trivellas, P., Malindretos, G., & Reklitis, P. (2020). Implications of green logistics management on sustainable business and supply chain performance: evidence from a survey in the greek agri-food sector. *Sustainability (Switzerland)*, *12*(24), 1–29. https://doi.org/10.3390/su122410515

Wang, Y., Yuan, Y., Guan, X., Xu, M., Wang, L., Wang, H., & Liu, Y. (2020). Collaborative two-echelon multicenter vehicle routing optimization based on state–space–time network representation. *Journal of Cleaner Production*, *258*. https://doi.org/10.1016/j.jclepro.2020.120590

Wasfi Al-Hattab, T. H., & Khashman, A. M. (2023). Business Process Re-Engineering and its Impact on Business Intelligence at Jordanian Commercial Banks. *International Journal of Academic Research in Business and Social Sciences*, *13*(12), 2505–2518. https://doi.org/10.6007/ijarbss/v13-i12/20104

Xu, J., Wu, H., Cheng, Y., Wang, L., Yang, X., Fu, X., & Su, Y. (2024). Optimization of Worker Scheduling at Logistics Depots Using Genetic Algorithms and Simulated Annealing. *ArXiv Preprint ArXiv:2405.11729*.

Yin, S., & Zhao, Y. (2024). Digital green value co-creation behavior, digital green network embedding and digital green innovation performance: moderating effects of digital green network fragmentation. *Humanities and Social Sciences Communications*, *11*(1). https://doi.org/10.1057/s41599-024-02691-5