

Modelling of Supply Chain Collaboration Enablers between Manufacturers and 3PL Providers

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ABSTRACT

Manufacturers and third-party logistics (3PL) providers must collaborate to enhance supply chain efficiency, adaptability, and customer responsiveness in a dynamic and competitive business landscape. However, effectiveness of collaboration is influenced through strategic, technological, and operational factors, but the connections among them is inadequately understood. The purpose of this research is to identify major enablers essential for collaboration between manufacturers and third-party logistics providers and establish inter-relationships among them to enhance supply chain performance. The study adopts a mixed-methods two-stage approach. First, Total Interpretive Structural Modeling (TISM) is used to examine the interrelationships among the refined set of enablers, providing a hierarchical model to show interpretive rationale of factor interdependencies. Secondly, the MICMAC analysis is done to categorize these enablers based on their driving and dependence power. The results reveal a structured hierarchy of collaborative enablers among manufacturer–3PL relationships. The major finding of this research demonstrates that strategic alignment and partnership orientation drive information sharing and decision synchronization between manufacturers and 3PLs. These interactions improve process efficiency and service quality, ultimately leading to higher ROI and market growth. The integrated TISM–MICMAC analysis finds critical characteristics required for fostering effective collaboration and impacting comprehensive supply chain integration. The research offers valuable insights to supply chain professionals and policymakers, by highlighting where to focus for smoother collaboration between manufacturer and 3 PL providers. The findings provide substantial theoretical and managerial insights by clarifying the structural connections among cooperation aspects in manufacturer–3PL partnerships. The study offers a systematic approach to assist managers in identifying critical enablers, improving collaborative strategies, and increasing operational efficiency and sustainable supply chain partnerships.

Keywords: Supply Chain Collaboration, Third-Party Logistics (3PL), Total Interpretive Structural Modelling (TISM), MICMAC Analysis, Collaboration Enablers, Manufacturer–3PL Integration.

INTRODUCTION:

Over the past several decades, logistics activities have increasingly been sourced out to specialized third-party logistics providers (3PLs) for enhancing integration capabilities and real-time flexibility solutions (Hofmann & Osterwalder, 2017). Through collaborative planning strategies, the third-party logistics (3PL) has played a vital role in global supply chain system for providing low-cost and efficient delivery services (Vlachos & Polichronidou, 2024). Supply chain collaboration is the process where more than two independent firms jointly plan, execute, and monitor different supply chain operational function, by sharing both rewards and risks,

with high level of trust factor (Gitau, 2022). This can be conceptualized as a business process wherein collaborative partners engage closely to pursue shared objectives that mutually enhance the performance of the involved firms (Tripathi et al, 2023). In particular, the relationship between manufacturers and third-party logistics service providers (3PLs) has emerged as a cornerstone for achieving operational excellence and sustaining competitive advantage in the face of rising consumer expectations and market complexities (Sireli, & Naik 2025). Supply chain collaboration is essential because of the sizeable, multitiered supply chains and countless interdependent components as well as the growing requirement to reduce risks and deal with

disruptions. The collaboration between the manufacturer and the 3PLs incorporates several supply chain operations such as- production planning, managing inventory, demand forecasting, distribution & order fulfilment (Xu et al. 2023). In the Indian context, this partnership holds immense potential, given the nation's promising manufacturing sector and the growing role of logistics in facilitating economic growth.

Recent research increasingly emphasizes the vital role of collaboration between 3PL service providers and manufacturers in enhancing overall supply chain performance. Current trends in globalization, e-commerce expansion, and digitalization have accelerated the demand for specialized logistics services, making the collaboration between manufacturers and 3PLs crucial for maintaining competitive advantages. In the Indian context, the importance of this partnership is magnified by the unique challenges and opportunities present in the market. In the past numerous authors have use the word "collaboration" casually. We ought to be conscious that there are several diverse supply chain relationships designs that may exist, and not all of them correspond to collaboration (Tsanos *et al.*, 2014).

As supply chains grow more complex and globally integrated, traditional transactional relationships are being replaced by strategic partnerships based on shared information, mutual trust, and joint decision-making. Effective collaboration enables manufacturers and 3PLs to synchronize operations, reduce costs, improve flexibility, and respond more efficiently to market fluctuations. Prior studies highlight the increasing importance of 3PL providers in enhancing supply chain performance through collaboration, service quality, innovation and information sharing. Studies have examined various aspects such as process innovation and knowledge transfer (Żywiłek et al., 2025), service quality and customer satisfaction (Chatzoudes et al., 2025), financial and technological support in supply chains (Shi et al., 2025; Singh, 2025), and the role of information sharing, trust, and collaborative efficacy in improving supply chain performance (Baah et al., 2022; Kim & Kim, 2024; Mahadevan et al., 2023). Additionally, earlier research has shown that manufacturer–3PL collaboration can enhance innovation, resource commitment, and competitive advantage (Sinkovics et al., 2018; Tran et al., 2024). However, existing studies mainly focus on the outcomes of collaboration, with limited attention given to systematically identifying and structuring the key enablers that drive effective collaboration between manufacturers and 3PL providers. This gap raises the research question: What are the critical enablers influencing manufacturer–3PL supply chain collaboration and how do they contribute to improved performance and market growth?

So, in today's competitive environment, there is an urge to overcome the limitations of traditional isolated functions in organizations and to move to relationships with others that enable trust, cooperation, and joint problem solving. This study addresses the development of a robust supply chain collaboration model that enhances the synergy between manufacturers and 3PL service providers, catering to the unique challenges and

opportunities in the Indian context. The purpose of this study is to systematically identify and analyse the key enablers of supply chain collaboration between manufacturers and third-party logistics (3PL) service providers in the Indian context. This research is undertaken with the following objectives:

RO 1: To identify the enablers that impact efficient collaboration between 3PL service providers and manufacturers.

RO 2: To develop a hierarchical framework to understand the direct and indirect interrelationships among them within the collaborative supply chain.

RO 3: To categorize the enablers according to their driving and dependent power using MICMAC analysis.

The first objective is achieved by comprehensive literature review to identify the key enablers that influence effective collaboration between 3PL providers and manufacturers. This study identifies 14 relevant and influential enablers that shape collaborative supply chain management and represent the possible interrelationships among them. The second objective is accomplished using the TISM (Total Interpretive Structural Modelling) methodology, which establishes direct and indirect interrelationships among the collaboration enablers and explains the logical reasoning behind the strength and direction of each connection. Finally, the identified enablers are classified through MICMAC analysis based on their driving and dependence power, completing the third objective of this research. The research provides pragmatic insights for managers aiming to establish robust, efficient, and well-coordinated supply chain partnerships, therefore enhancing decision-making, performance, and long-term competitive advantage. This structured approach facilitates the development of successful cooperation strategies, aligns logistical capabilities with production objectives, and improves overall supply chain performance. This study substantially enhances the current understanding of supply chain cooperation by methodically defining and examining the principal factors that bolster collaborative performance among partners.

The remaining paper is structured as follows: Section 2 briefly explains the background of study and literature review on different enablers of supply chain collaboration among 3 PL and manufacturers. Section 3 demonstrates the research methodology used in this research. Section 4 explains the implementation steps of TISM model for Supply Chain collaboration between 3PL and manufacturers. Section 5 is for Classification of MICMAC Analysis. Results and findings are explained under section 6. Further managerial implications are written in section 7, followed conclusion in section 8.

LITERATURE REVIEW

Due to the rapid development of technology and market pressure, Third-Party Logistics(3PL) provider increasingly has been dependent by many manufacturing companies for its integration function with real-time flexibility solutions. With joint planning, innovation and

responsiveness as well as other strategic values, the function of 3PL changed from the low cost and efficient delivery service into a new business partner in global supply chain system (Darko & Vlachos, 2022). The collaboration process in which two or more independent firms collaboratively plan, act and monitoring supply chain activities on mutual risk and gain with the high trust is called Supply Chain Collaboration (Gitau 2022). Partnership among manufacturer and 3PL extend across a number of functions of the supply chain such as production planning, inventory management, order fulfilment and demand forecast (Kmieciak, 2025).

2.1 Review related with collaboration among 3PL and Manufacturers

Supply chain collaboration (SCC) has gained momentum in today’s global marketplace as it has proved to be a valuable source of competitive advantage through the value created within the supply chain for the supply chain partners and end consumers. Supply chain collaboration is

defined from multiple perspectives, focusing on cooperation, relationships, and mutual benefits (Soosay & Hyland, 2015). It also refers to the strategic partnership and mutual engagement between third-party logistics providers (3PLs) and manufacturers to co-create value and improve supply chain performance (Sinkovics et al., 2018). It is characterized by various interactive mechanisms such as information sharing, which ensures transparency and informed decision-making; goal congruence, which aligns strategic objectives; and decision synchronization, where decisions are jointly made to benefit both parties (Chatzoudes et al., 2025) . Additionally, incentive alignment ensures that both entities benefit fairly from the collaboration (Paavola et al., 2025), while resource sharing reflects the joint utilization of tangible and intangible assets (Larabi 2025). Collaborative communication fosters ongoing dialogue, and joint knowledge creation supports innovation and learning, further strengthening the collaborative bond (Saragih, 2025). Table.1 explains the recent literature related with collaboration of 3 PLs & manufacturer in supply chain.

Table 1: Recent studies related with collaboration among 3PL and manufacturers in supply chain

Authors	Findings & Objectives of study
Huang et al., (2025)	The effectiveness of the emerging role of third-party logistics is being evaluated, and potential limitations are being investigated.
Żywiołek et al., (2025)	Examine the influence on process innovation, knowledge transfer, and security integration within complex supply chains among organizations.
Chatzoudes et al., (2025)	It explores the effects of 3PL service quality on customer satisfaction, mutual loyalty, supply chain performance, competitive advantage and firm performance.
Shi et al., (2025)	This study provides novel insights into how 3PL providers, leveraging their financial capacity, can deliver innovative financial solutions to supply chain stakeholders—particularly SMEs.
Singh (2025)	Explores the moderating impact of technology on operational efficiency and environmental sustainability.
Kim & Kim (2024)	Explores that Cognitive trust is more significant than emotional trust. Trust-based collaborative risk management leads to better logistical performance.
Tran et al., (2024)	Investigate how Organizational and contextual factors affect supply chain collaboration and how that, in turn, influences firms’ competitive advantage in the garment industry
Mahadevan et al., (2023)	Examine the performance of supply chain via collaborative efficacy from organizations in the Asia-Pacific area.
Baah et al., (2022)	Evaluates the essential function of information sharing highlighting its impact on supply chain visibility, cooperation, agility, and overall performance.
Kumar et al., (2021)	The study identifies three profiles of collaboration and discusses the importance of SCC activities in achieving performance
Solaimani & van der Veen (2022)	This study elaborates how supply chains can facilitate supply chain collaboration and adopt a more open approach toward innovation.
Sinkovics et al., (2018)	This study examines how manufacturer-3PL collaboration influences resource commitment, innovation, and performance.

This Paper	To explore and identify significant enablers of supply chain collaboration between manufacturers and 3 PL service provider to attain good returns and market growth.
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Enablers of Supply chain Collaboration among Manufacturer and 3PLs provider

This section examines the key enablers of supply chain collaboration between manufacturers and third-party logistics (3PL) service providers. Previous studies highlight the multidimensional nature of 3PL service quality, incorporating factors like responsiveness, reliability, IT integration and value-added services (German et al., 2022). Moreover, relational factors, such as trust, long-term collaboration and mutual commitment, are increasingly recognized for their impact on service outcomes and customer loyalty (Yang and Yu, 2019). Sharing Information, Goal congruence/goal sharing and joint decision-making are a few collaborative practices which help in encouraging the relationship between both the party's value co-creation (Makaci et al., 2025). With the digital revolution and data-driven supply chain, 3PLs are more given wider role as they contribute to the organization of innovation, sustainability and overall resilience in manufacturing ecosystems (Creazza et al., 2024). The major enablers identified from comprehensive literature is illustrated below-

1. Information Sharing (E-1):

In the light of the pandemic, sharing Information up and down in the supply chain is necessary. As a result of that, visibility and operations are driven by a wide range of logistics and production networks. Sufficient and accurate information about the market gives both supplier and buyer higher probability to foresee demand, thus prepare for inventory in advance, as a result of reduce uncertainty disturbance (Zhou et al., 2023). Based on this, trust is gained and works as a driver for fast decision taking and reaction to situation in the marketplace. In collaborative networks, timely and accurate information exchange on pertinent issues (i.e. ongoing activities, planned next actions, relevant events or failures), amongst the participants in a cross-organizational way, allows to form common knowledge and cooperative responses of the partners involved (Huo et al., 2021).

2. Strategic Goal alignment (E-2):

It guarantees that the goals of both manufacturers and 3PLs are aligned. When both firms adopt common goals, such as delivery reliability, costs reduction and innovations, the collaboration is moved from transactional to strategic relationship (Tiwari et al., 2024). This alignment helps to reduce conflict, promote ongoing improvement and ensure performance measures are constructive for both the parties. When members of the supply-chain partners align their individual goals with shared collaborative objectives, it is possible to generate synergic effects and improve joint performance (García-Alcaraz et al., 2022).

3. Decision Synchronization (E-3):

Synchronizing decisions allows manufacturers and 3PLs to collaborate on strategic planning and execution, ranging from manufacturing planning through the transportation route planning (Premkumar et al., 2021). Synchronized decision making enables companies to achieve agility and pool resources to address variable demand. This partnership reduces duplication and strengthens operational resilience. Decision synchronization is the simultaneous planning and execution of strategic decisions (e.g. demand forecasting, replenishments and schedules) across supply chain partner to maximize performance as a whole rather than that from an individual organization (Fayezi & Ghaderi 2022).

4. Incentive Alignment (E-4):

Incentive alignment motivates all parties to achieve group success by linking rewards and penalty to overall performance. When the goals are common in terms of money or operational activities, both 3PL firms and manufacturers demonstrate a tendency to achieve end-to-end efficiency (Selviaridis & Spring 2018). This alignment encourages trust, transparency and shared accountability for results. Reward systems, risk-sharing arrangements, and performance-metrics must be in place as these go a long way in streamlining the supply chain's goals; with misaligned incentives which may discourage cooperation resulting into a suboptimal (chain) outcome (Rejeb et al., 2021).

5. Resource Sharing (E-5):

Using shared assets in collaborative firms leads to reduce in cost reduction and improve efficiency. In this they use both technical and non-technical advantage of their partners (Gitau 2022). While using resources, trust is built which leads to joint responsibility and enhancement of information sharing. Also, this leads to mitigation of duplication of efforts or resources (Mustapha et al., 2022).

6. Collaborative Communication (E-6):

Communication is the key to provide essential information that can be beneficial to forecast the risk and issues faced by both manufacturers and logistics sectors. Through various platforms information can be transferred both in digital and manual medium. Through this they can get the holistic understanding of the problem or issue (Sankar & Gopalakrishnan 2024). Communication should be multidirectional, as in both sectors (manufacturing and logistics) if the information is not conveyed on time can lead to a major loss and other problems which harm them in both financial and social aspects (good will) (Ghobakhloo et al. 2025).

7. Joint Knowledge Creation (E-7):

Through the use of resources of both collaborators, the desired information is obtained that benefits both the sectors or company in long terms (Zarbakshnia & Karimi (2024). Joint knowledge creation is a powerful tool that helps both the firms in the collaboration to have a competitive advantage over other competitors in this fast-changing market place (Zhang et al.. 2025).

8. Business Synergy (E-8):

Business Synergy (E-8) in the context of supply chain collaboration between 3PL providers and manufacturers refers to the enhanced value and collective performance that arise when both partners align their strengths, processes, and strategic objectives. In integrated supply chains, manufacturers bring capabilities in production planning and product design, while 3PLs contribute expertise in logistics operations, transportation, and distribution. When these complementary capabilities are coordinated through information sharing, joint planning, technology integration, and mutual trust, they create synergy that leads to superior outcomes. Business Synergy manifests in reduced operational costs, optimized resource utilization, improved service levels, and faster response to market fluctuations (Feizabadi and Alibakhshi 2022). It also enables co-innovation, as partners collaborate on digital solutions and process improvements that neither could implement as effectively alone.

9. Long term partnership Orientation (E-9):

Long-Term Partnership Orientation (E-9) refers to the shared strategic mindset of both 3PL providers and manufacturers to build and sustain a collaborative relationship that extends beyond transactional or short-term contractual engagements. In supply chain collaboration, this orientation emphasizes mutual commitment, continuity, and joint value creation over time, rather than focusing solely on immediate cost savings or short-term performance outcomes. When both parties adopt a long-term perspective, they are more willing to invest in relationship-specific assets, such as integrated information systems, co-developed logistics processes, or customized service capabilities. This forward-looking approach promotes deeper trust, openness, and alignment of strategic objectives, enabling smoother coordination and joint problem-solving. Long-term partnership orientation also reduces opportunistic behavior and supports consistent communication, which strengthens the relational fabric of the collaboration. (Kumar, 2021; Tran et al., 2024)

10. Service quality Consistency (E-10):

By the joint efforts of logistics and manufacturing sector in a company they can excel the quality and control the overall damage in the in the whole supply chain. Real time monitoring is the real plus in the collaboration as through this the time taken to act on an issue decreases (Gitau., 2022). When both the sectors work collectively they shared same quality norms, that decrease the rate for

rejection as both the parties know the threshold of their companions (Annosi et al.. 2021).

11. Process Efficiency (E-11):

Collaboration enhances the process efficiency by decreasing the unnecessary formal steps. This also helps to reduce the confusion among the sectors and within a sector (Yeung, et al. 2022). Reducing confusion leads to high level of understanding among the manufacturer and logistic provider and as a result timely delivery of products from supplier and to the buyer can be achieved. This cause the whole process to more efficient and progress towards lean supply chain management where the wastage of resources is not an issue (Benzidia & Bentahar 2025).

12. Return on investment (E-12):

As collaboration is a huge investment at the start of it, because it requires a lot of new infrastructure, we need to focus on the ROI aspect (Israel et al., 2023). Through various collaboration in long term, all sectors involved gets benefits from it (Baah et al., 2022; Gupta et al..2025). As various parties invest their resources on a single issue or technology the cost to develop the same technology individually is always greater. This helps in risk reduction and have market competition advantage over their competitors.

13. Collaboration Process Innovation (F-13):

Companies do various collaborative research and development projects that benefits both or every partner of collaboration (Yu et al., 2025).Through these collaborative learning new solutions are used to treat the existing issues more efficiently and provide a efficient supply chain performance (Lu et al. 2021).

14. Market Growth (E-14):

Due to high performance of supply chain, the service level of a company also have an advantage (less lead time) over their competitors which result in making a possibility to achieve higher sales volumes (Giannikas et al.. 2019). By connecting planning, firms can also close the mismatch between production and fluctuations in demand to generate additional income. Companies connect the practices of their supply chains such as speed, performance and innovation with those that are important to customers and report higher growth in sales and market share (Schrock et al.. 2024). Even various companies are now focusing on sustainability and as a result main focus of various industries in collaboration is on sustainability. When any two companies reach a certain level of understanding and trust, they can negotiate and ask each other to take initiative towards sustainable growth. (Creazza et al. 2024). This sustainable growth not only helps the environment but also helps a company to balance their cost and reduce the additional usage of resources, which result in a financial benefit. Using sustainable technology from various companies can also impact the

overall understanding and operations of a company (Małys 2023).

Research Methodology

This section presents the integrated methodological approach used to assess and evaluate the key enablers that

support effective supply chain collaboration between 3PL providers and manufacturers. It outlines the techniques applied in this study, the overall research framework, and the process followed to identify the critical collaboration enablers. The methodology provides a structured foundation for understanding how different factors interact to enhance coordination, efficiency, and performance within the 3PL–manufacturer partnership.

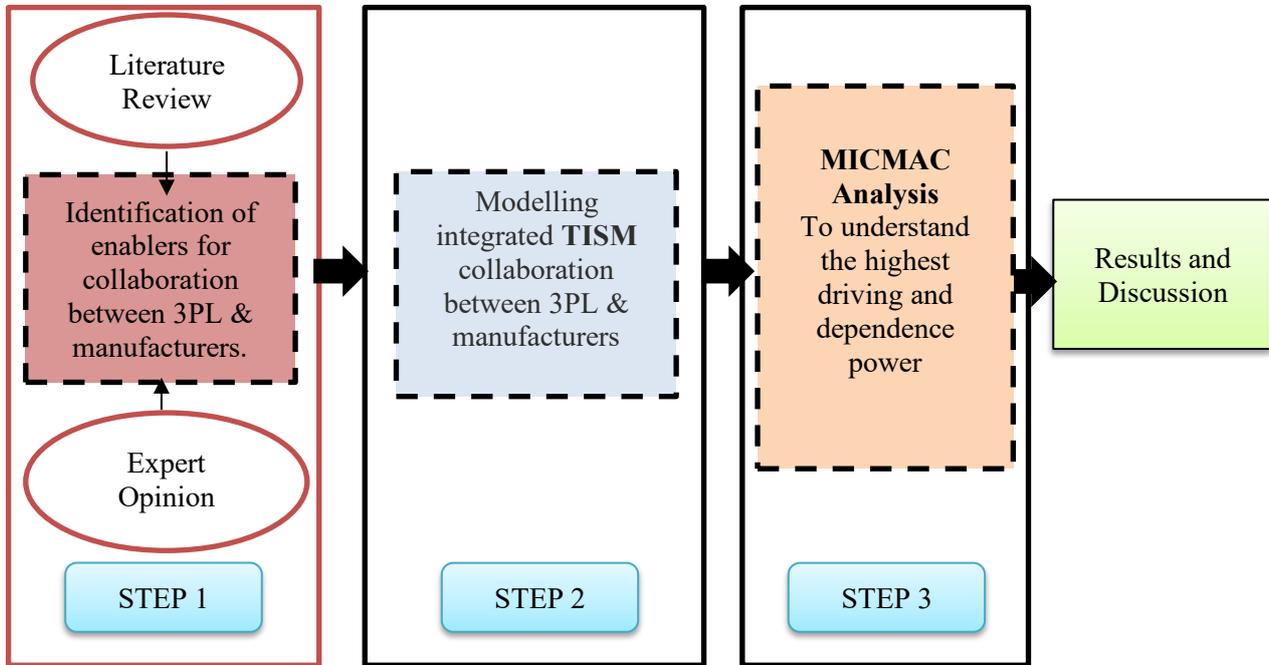


Figure 1: Schematic flow of research

Research framework for current research

The entire schematic flow of this research is illustrated in Figure 1. It consists of three major steps. First, the study identifies the key enablers that influence effective collaboration between 3PL providers and manufacturers through an extensive literature review and expert consultation. Second, the TISM (Total Interpretive Structural Modelling) methodology is applied to establish the direct and indirect interrelationships among these enablers and to develop a hierarchical structural model that explains how each factor logically influences others within the collaborative supply chain. Finally, MICMAC analysis is conducted to graphically classify the enablers based on their driving and dependence power, providing a clear understanding of which factors act as foundational drivers and which ones emerge as dependent outcomes in the 3PL–manufacturer collaboration framework.

Identification of Enablers of Collaboration

The key enablers of supply chain collaboration between manufacturers and third-party logistics (3PL) service providers are discussed in section 2.2.

Methodology

TISM and MICMAC are complementary methodological tools used to analyze and achieve the objectives of effective supply chain collaboration between 3PL providers and manufacturers. The Total Interpretive Structural Modeling (TISM) approach helps establish the contextual and mutual interactions among key collaboration enablers, offering deeper interpretive insights into how one enabler influences, supports, or depends on another within the collaborative supply chain environment. TISM not only identifies the direction of influence but also explains the logic behind each relationship, thereby revealing the hierarchical structure of enablers such as trust, information sharing, technology integration, long-term partnership orientation, and business synergy. Following the development of this structural model, MICMAC analysis is used to classify the identified enablers into four categories—driving, dependent, linkage, and autonomous variables—based on their driving power and dependence power. This classification helps determine which enablers act as foundational drivers, which ones are outcomes, which are unstable linkage elements, and which play a relatively minor role. Together, TISM and MICMAC provide a robust framework to understand, prioritize, and enhance collaborative practices between 3PLs and manufacturers.

Development of Questionnaire

To assess the critical enablers that support effective supply chain collaboration between 3PL service providers and manufacturing firms, a structured questionnaire was

developed to capture respondents' perceptions regarding the significance of various collaboration enablers. The initial set of enablers was identified through an extensive review of existing literature on logistics collaboration, third-party logistics partnerships, and supply chain integration. To ensure the accuracy and practical relevance of the instrument, a pilot study was conducted with eight domain experts—two senior logistics managers from 3PL companies, two supply chain managers from manufacturing firms, two consultants specializing in logistics and supply chain strategy, and two academic experts in operations and supply chain management. These experts evaluated the clarity, completeness, and contextual suitability of the questionnaire items. Based on their feedback, several refinements were incorporated to enhance the validity and usability of the survey before administering it to a larger sample for the main study.

Data collection

The refined questionnaire was subsequently distributed to 12 professionals representing key stakeholder groups involved in logistics and manufacturing operations in India. The survey was administered via email, and follow-up reminder emails—and in some cases phone calls—were used to encourage participation. Among the 12 respondents, 4 were senior managers from third-party logistics (3PL) firms, 4 were supply chain and operations managers from manufacturing organizations, 2 were industry consultants and officials from logistics-related government bodies, and 2 were academic experts specializing in supply chain management. A majority of the respondents possessed more than fifteen years of professional experience, ensuring that the insights collected were grounded in substantial industry knowledge and practical expertise. This diverse and experienced respondent base strengthened the reliability and relevance of the collected data for analyzing collaboration enablers between 3PLs and manufacturers.

Total Interpretive Structural Modeling (TISM)

The latest evolution of Interpretive Structural Modelling (ISM) is the Total Interpretive Structural Modelling (TISM) approach proposed by Shankar et al. (2018). TISM enhances traditional ISM by offering a clearer and more structured way to represent complex systems, helping researchers move from vague models to well-defined conceptual structures (Sushil, 2018). One of the major limitations of conventional ISM is its weak explanation of relationships between elements and its tendency to overlook transitive linkages in the digraph. TISM overcomes these issues through an Interpretive Matrix, which allows researchers to articulate the meaning behind each connection and capture all relevant linkages among enablers. With its ability to explain the “what,” “why,” and “how” of theoretical relationships, TISM has been widely applied across different domains—for example, to study the smartphone manufacturing ecosystem (Jena et al., 2017) and challenges associated with integrating batteries into the electrical grid (Gupta and Shankar, 2023). Given these strengths, the present study adopts TISM to explore and map the interdependencies among critical success enablers for collaboration between 3PLs and manufacturers.

Modelling integrated TISM for Supply Chain collaboration between 3PL and manufacturers

The 14 critical enablers influencing supply chain collaboration between 3PL providers and manufacturers are structured in a hierarchical manner using the TISM methodology. The study follows a seven-step TISM procedure, as suggested by Jena et al. (2017), to systematically establish and interpret the relationships among these collaboration factors. Figure 2 presents the proposed research framework that outlines the methodological steps undertaken to achieve the stated research objectives.

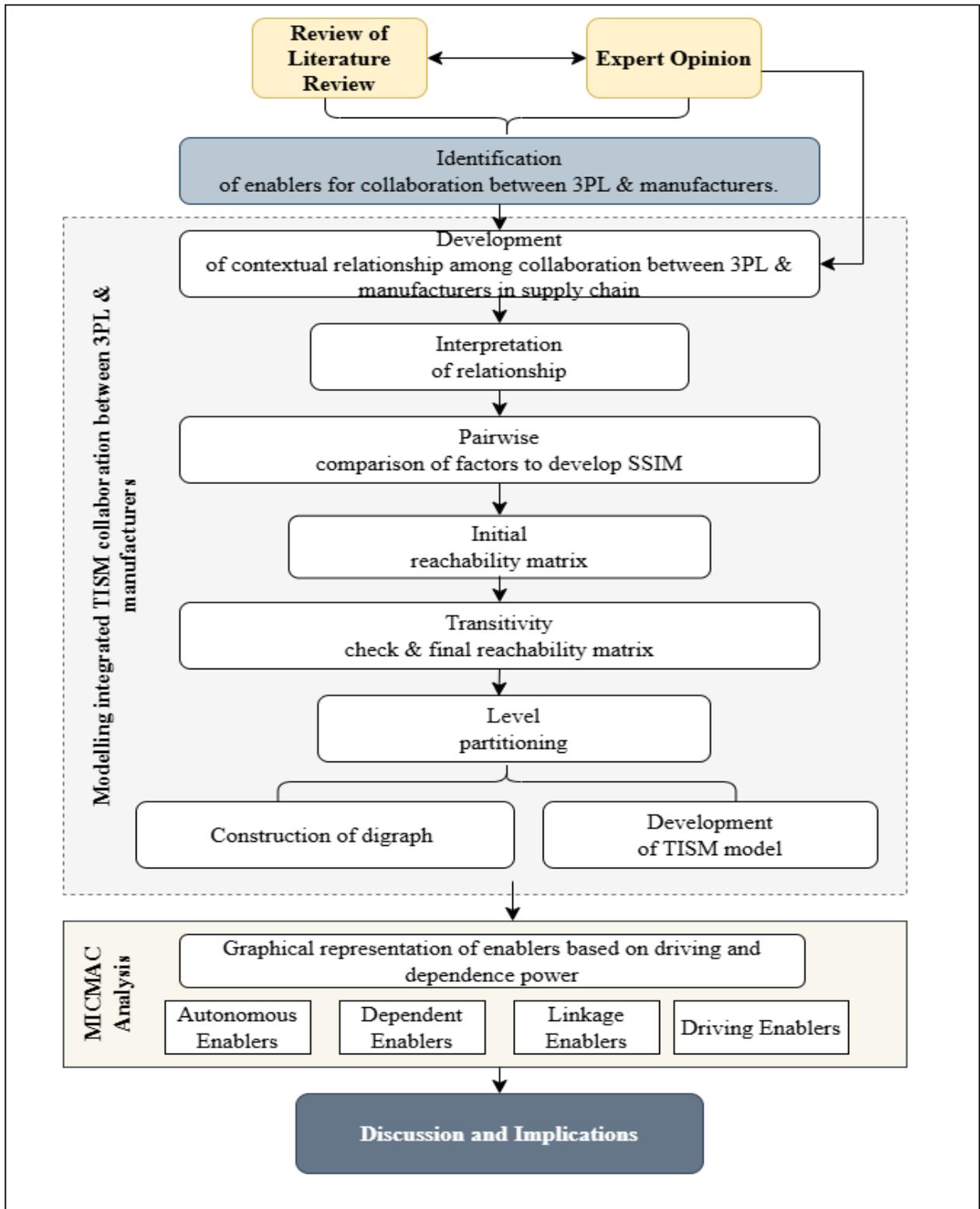


Figure 2:Suggested research methodology

Step I: Identification of enablers

In this study, 14 key enablers that influence effective collaboration between 3PL providers and manufacturers were identified through an extensive literature review and supplemented by insights gathered from semi-structured interviews with industry experts. These expert inputs helped validate and refine the list of collaboration factors, ensuring that the selected enablers are both theoretically

grounded and practically relevant for developing the TISM model.

Step II: Determination of contextual relationship

To achieve the objective of this study, the contextual relationship between different Enablers is described as “Enabler 1 (E1) will influence or enhance Enabler 2 (E2)”.

Step III: Interpretation of relationship

Expert opinions are gathered to demonstrate if "E-1 will impact or enhance E-2" or not. If this contextual link indicates "yes," it is also shown "how E-1 will impact or increase E-2".

Given that there are two possible directional links—i-j or j-i—there will be a total of 14 (14 - 1) = 182 pair-wise comparisons for the 14 identified enablers. As a result, the knowledge base for this research will have 182 numbers. Experts' opinions are indicated for each pair-wise comparison by the entry symbols "N" for no and "Y" for yes, and if it is of the "Y" type (Shown in Table 2), further interpretation is also provided (*Appendix I*)

Step IV: Interpretive logic-knowledge base for pair-wise comparison

An "interpretive logic-knowledge base" is developed to express the pair-wise comparison of identified enabler.

Table 2: Interpretive pair wise comparison

Interpretive pair wise comparison														
Collaboration Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	Y	N	Y	N	Y	Y	N	N	N	N	N	Y	N	N
E2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
E3	Y	N	Y	N	Y	Y	N	N	N	N	N	N	N	N
E4	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
E5	N	N	N	N	Y	Y	N	N	N	Y	Y	N	Y	Y
E6	N	N	N	N	Y	Y	N	N	N	Y	Y	Y	Y	Y
E7	Y	N	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y
E8	Y	N	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	Y
E9	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
E10	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
E11	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
E12	N	N	N	N	N	N	N	N	N	N	N	N	N	Y
E13	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y
E14	N	N	N	N	N	N	N	N	N	N	N	Y	N	N

Step V: Reachability matrix and transitivity test

By assigning 1 for the "Y" and 0 for the "N" in the knowledge base, the initial reachability matrix is constructed from the interpretative logic-knowledge base (Table 3). The transitivity rule is then used to convert the initial reachability matrix into the final reachability matrix. For example, if "E1 relates to E2" and "E2 relates to E5," then "E1 surely relates to E5." Every transitive link is updated in the knowledge base with "Y," and "transitive" is denoted in the corresponding interpretation column. The initial reachability matrix is shown in (Table 4). where 1* indicates that there is a transitive relationship between two enablers.

Table 3: Initial Transitivity Matrix

Initial Transitivity Matrix														
Collaboration Factors	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
E1	1	0	1	0	1	1	0	0	0	0	0	1	0	0
E2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
E3	1	0	1	0	1	1	0	0	0	0	0	0	0	0
E4	1	0	1	1	1	1	1	1	0	1	1	1	1	1
E5	0	0	0	0	1	1	0	0	0	1	1	0	1	1
E6	0	0	0	0	1	1	0	0	0	1	1	1	1	1
E7	1	0	1	1	0	0	1	1	0	1	1	1	1	1
E8	1	0	1	1	0	0	1	1	0	1	1	1	1	1
E9	1	1	1	1	1	1	1	1	1	1	1	1	1	1
E10	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E11	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E12	0	0	0	0	0	0	0	0	0	0	0	0	0	1
E13	0	0	0	0	0	0	0	0	0	1	1	1	1	1
E14	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Table 4: Final Transitivity Matrix

Final Reachability Matrix															
Collaboration Enablers	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	Driving Power
E1	1	0	1	0	1	1	0	0	0	1*	1*	1	1*	1*	9
E2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
E3	1	0	1	0	1	1	0	0	0	1*	1*	1*	1*	1*	9
E4	1	0	1	1	1	1	1	1	0	1	1	1	1	1	12
E5	0	0	0	0	1	1	0	0	0	1	1	1*	1	1	7
E6	0	0	0	0	1	1	0	0	0	1	1	1	1	1	7
E7	1	0	1	1	1*	1*	1	1	0	1	1	1	1	1	12
E8	1	0	1	1	1*	1*	1	1	0	1	1	1	1	1	12
E9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14
E10	0	0	0	0	0	0	0	0	0	1	1	1	1	1	5
E11	0	0	0	0	0	0	0	0	0	1	1	1	1	1	5
E12	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1

E13	0	0	0	0	0	0	0	0	0	1	1	1	1	1	5
E14	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Dependence	7	2	7	5	9	9	5	5	2	12	12	13	12	13	

* Part showing transitivity

Step VI: Level determination by partitioning reachability matrix

To determine the hierarchical positioning of the collaboration enablers, the reachability matrix was level-partitioned following the procedure outlined by Ravi and Shankar (2005). Table 5: presents the level assignment derived from the final reachability matrix for the selected enablers. These identified levels form the basis for constructing the digraph and developing the TISM-based structural model that illustrates the interrelationships among the critical enablers influencing collaboration between 3PL providers and manufacturers.

Table No. 5: Partitioning of reachability matrix (iteration 1–6).

Iteration-I

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E1	1,3,5,6,10,11,12,13,14	1,2,3,4,7,8,9	1,3	
E2	1,2,3,4,5,6,7,8,9,10,11,12,13,14	2,9	2,9	
E3	1,3,5,6,10,11,12,13,14	1,2,3,4,7,8,9	1,3	
E4	1,3,4,5,6,7,8,10,11,12,13,14	2,4,7,8,9	4,7,8	
E5	5,6,10,11,12,13,14	1,2,3,4,5,6,7,8,9	5,6	
E6	5,6,10,11,12,13,14	1,2,3,4,5,6,7,8,9	5,6	
E7	1,3,4,5,6,7,8,10,11,12,13,14	2,4,7,8,9	4,7,8	
E8	1,3,4,5,6,7,8,10,11,12,13,14	2,4,7,8,9	4,7,8	
E9	1,2,3,4,5,6,7,8,9,10,11,12,13,14	2,9	2,9	
E10	10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	
E11	10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	
E12	14	1,2,3,4,5,6,7,8,9,10,11,13,14	14	I
E13	10,11,12,13,14	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	
E14	12	1,2,3,4,5,6,7,8,9,10,11,12,13	12	I

Iteration-II

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E1	1,3,5,6,10,11,13	1,2,3,4,7,8,9	1,3	
E2	1,2,3,4,5,6,7,8,9,10,11,13	2,9	2,9	
E3	1,3,5,6,10,11,13	1,2,3,4,7,8,9	1,3	
E4	1,3,4,5,6,7,8,10,11,13	2,4,7,8,9	4,7,8	
E5	5,6,10,11,13	1,2,3,4,5,6,7,8,9	5,6	

E6	5,6,10,11,13	1,2,3,4,5,6,7,8,9	5,6	
E7	1,3,4,5,6,7,8,10,11,13	2,4,7,8,9	4,7,8	
E8	1,3,4,5,6,7,8,10,11,13	2,4,7,8,9	4,7,8	
E9	1,2,3,4,5,6,7,8,9,10,11,13	2,9	2,9	
E10	10,11,13	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	II
E11	10,11,13	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	II
E13	10,11,13	1,2,3,4,5,6,7,8,9,10,11,13	10,11,13	II

Iteration-III

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E1	1,3,5,6	1,2,3,4,7,8,9	1,3	
E2	1,2,3,4,5,6,7,8,9	2,9	2,9	
E3	1,3,5,6	1,2,3,4,7,8,9	1,3	
E4	1,3,4,5,6,7,8	2,4,7,8,9	4,7,8	
E5	5,6	1,2,3,4,5,6,7,8,9	5,6	III
E6	5,6	1,2,3,4,5,6,7,8,9	5,6	III
E7	1,3,4,5,6,7,8	2,4,7,8,9	4,7,8	
E8	1,3,4,5,6,7,8	2,4,7,8,9	4,7,8	
E9	1,2,3,4,5,6,7,8,9	2,9	2,9	

Iteration-IV

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E1	1,3	1,2,3,4,7,8,9	1,3	IV
E2	1,2,3,4,7,8,9	2,9	2,9	
E3	1,3	1,2,3,4,7,8,9	1,3	IV
E4	1,3,4,7,8	2,4,7,8,9	4,7,8	
E7	1,3,4,7,8	2,4,7,8,9	4,7,8	
E8	1,3,4,7,8	2,4,7,8,9	4,7,8	
E9	1,2,3,4,7,8,9	2,9	2,9	

Iteration-V

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E2	2,4,7,8,9	2,9	2,9	
E4	4,7,8	2,4,7,8,9	4,7,8	V
E7	4,7,8	2,4,7,8,9	4,7,8	V
E8	4,7,8	2,4,7,8,9	4,7,8	V
E9	2,4,7,8,9	2,9	2,9	

Iteration-VI

Collaboration Enablers	Reachability Set	Antecedent Set	Interaction Set	Level
E2	2,9	2,9	2,9	VI
E9	2,9	2,9	2,9	VI

Step VII: Develop digraph

By placing each element at its appropriate level and displaying directed linkages in accordance with the relationship shown in the final reachability matrix, a directed graph for all enablers is created.

Step VIII: Interpretive matrix

The final digraph is first transformed into a binary interaction matrix by assigning a value of “1” to each cell where a relationship between two enablers exists. This binary matrix is then converted into an interpretive matrix by incorporating the detailed explanations from the interpretive logic–knowledge base corresponding to each identified interaction. The interpretive matrix provides clarity on the nature and meaning of the linkages between enablers. An illustrative interpretive matrix for the collaboration enablers between 3PL providers and manufacturers is provided in Appendix I.

Step IX: Total interpretive structural model

The interpretive matrix and the digraph are then combined to develop the TISM-based structural model for the critical enablers of collaboration between 3PL providers and manufacturers. In this model, the nodes in the digraph represent the individual enablers, while the links between them reflect the interpretive insights obtained from the interpretive matrix. This integration provides a detailed understanding of both the factors themselves and the nature of their interrelationships, resulting in a comprehensive and logically structured model. Figure 3 presents the integrated TISM model for 3PL–manufacturer collaboration, where solid lines indicate direct relationships and dotted lines represent significant transitive linkages

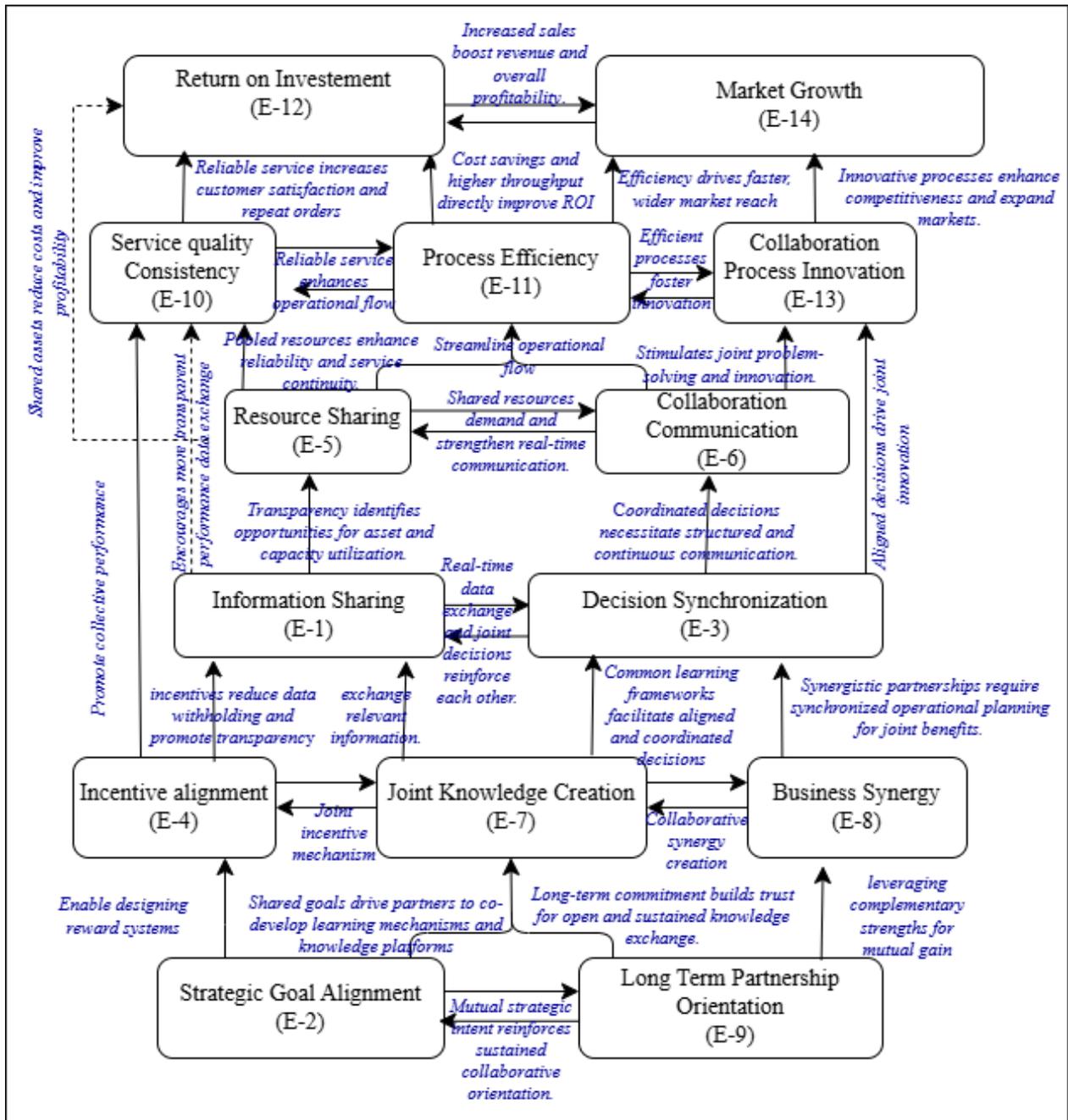


Figure 3: TISM model for Supply Chain collaboration (Between 3PL & Manufacturing)

Classification of MICMAC Analysis

Using the MICMAC analysis framework, the critical enablers of collaboration are classified based on their driving and dependence power, and the results are presented graphically. In the MICMAC graph, the y-axis represents the driving power of each enabler, while the x-axis indicates its dependence power. Based on these two dimensions, the enablers are grouped into four categories: Group A (autonomous), Group B (dependent), Group C (linkage), and Group D (driving). Figure 4 illustrates this classification and visually highlights the position of each enabler within the four MICMAC clusters.

Group-A i.e., Autonomous Enabler Usually, this group consists of those Enablers with weak drivers and weak

dependents. Here no enablers found to be autonomous enablers

Group-B i.e. Dependent Enablers, as they are strongly dependent upon certain enablers and drive others weakly. Group B involves five enablers E-10, E-11, E-12, E-13, E-14

Group C contains linkage Enabler in which any effect of these enablers influences other Enabler. Here enablers is identified i.e., E5, E-6, E-1, E-3

Group D enablers strongly drive others and weakly dependent on other enablers., in our case group D have following E2, E4, E7, E8, E-9.

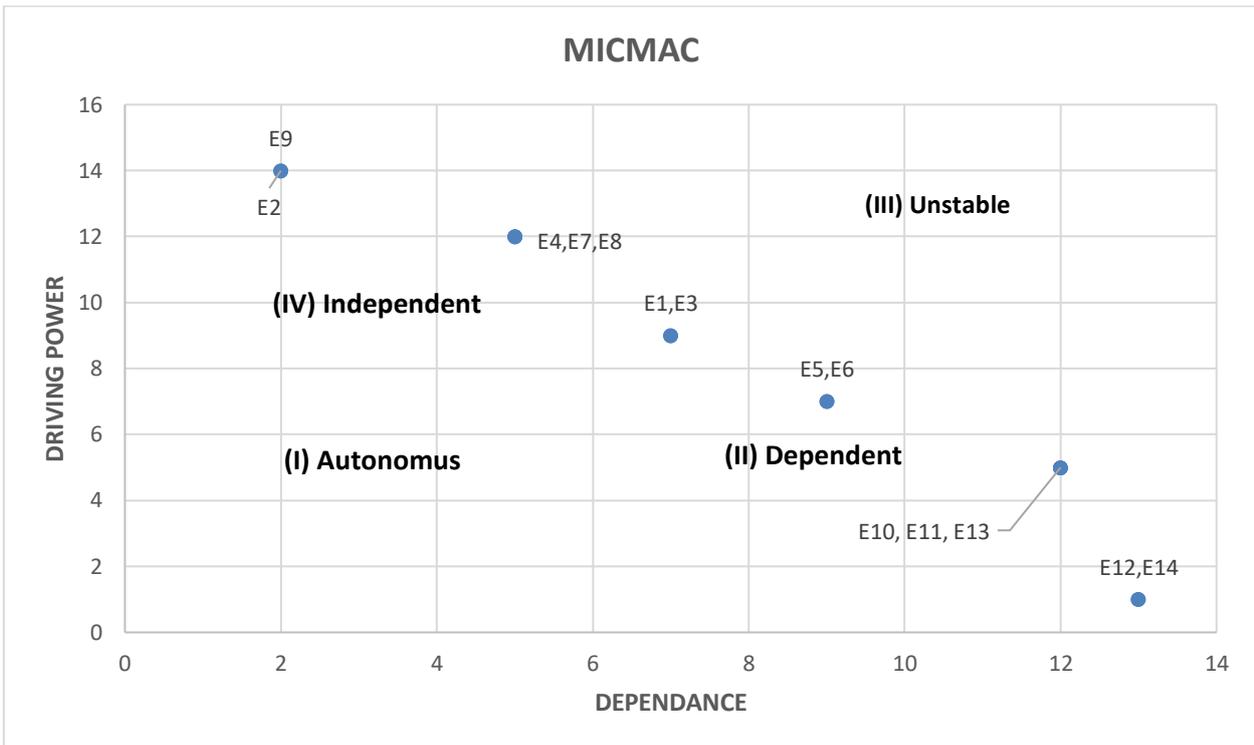


Figure 4: Classification of MICMAC Analysis

RESULTS & DISCUSSION

This study develops a hierarchical TISM model to evaluate the interrelationships among the critical enablers that support effective supply chain collaboration between third-party logistics (3PL) providers and manufacturers. The model highlights how foundational strategic drivers shape tactical, operational, and performance outcomes across the collaborative supply chain ecosystem. By interpreting both the direct and transitive relationships, the TISM structure provides a comprehensive understanding of how collaboration evolves and which factors exert the highest influence on performance.

The lowest level of the hierarchy consists of two fundamental drivers: Strategic Goal Alignment (E-2) and Long-Term Partnership Orientation (E-9). These enablers form the motivational and relational base of collaboration. When partners share mutual strategic objectives, it encourages coherent planning, balanced expectations, and aligned performance targets. Similarly, a long-term partnership orientation cultivates trust and commitment, encouraging firms to invest in shared processes, exchange resources, and engage in co-development of capabilities. Together, these enablers create the strategic environment that allows all other collaboration elements to emerge and function effectively.

Building on these foundational drivers, the next hierarchical layer includes Incentive Alignment (E-4), Joint Knowledge Creation (E-7) and business synergy (E-8). When incentives are aligned across partners, it discourages information withholding and promotes transparency in decision-making. Joint knowledge creation strengthens shared learning mechanisms and encourages partners to collaboratively build new capabilities. These two enablers act as pivotal

transformation points that translate strategic intentions into practical mechanisms for collaboration. Business Synergy (E-8) emerges as a result of effective coordination and communication. Synergy reflects the ability of both partners to leverage one another's complementary strengths to generate greater joint value. Through synergy, firms develop stronger operational bonds and integrate their processes more deeply, leading to more effective collaboration outcomes

As collaboration becomes more structured, the enablers of Information Sharing (E-1) and Resource Sharing (E-5) emerge as central tactical elements in the model. Transparent and real-time information exchange enhances the quality and speed of decisions across both organizations. Resource sharing allows partners to pool operational capacities, reduce redundancy, and improve reliability within the joint system. These tactical enablers are essential in transitioning collaboration from strategic intent to operational reality. The model then progresses to Decision Synchronization (E-3) and Collaboration Communication (E-6), which represent the advanced tactical stage of collaboration maturity. Decision synchronization ensures that both 3PLs and manufacturers coordinate their plans and execute aligned choices in real time. Collaboration communication strengthens structured dialogue and feedback mechanisms, allowing partners to jointly manage uncertainties and operational variabilities. Together, these enablers help maintain cohesiveness in day-to-day operations.

The operational stage of the hierarchy is represented by Process Efficiency (E-11), Collaboration Process Innovation (E-13), and Service Quality Consistency (E-10). Process efficiency arises when information, resources, and decisions are synchronized, resulting in streamlined operations and reduced waste. Collaboration process innovation emerges from joint

learning, problem-solving, and mutually aligned processes, driving new and improved ways of working. Service quality consistency reflects the enhanced reliability and uniformity of service performance resulting from integrated processes, shared resources, and efficient workflows. These operational enablers collectively improve the functioning of the 3PL–manufacturer collaboration system.

At the top of the hierarchy, the model identifies two key performance outcomes: Return on Investment (E-12) and Market Growth (E-14). Return on investment is strengthened through improved throughput, reduced operational delays, efficient resource utilization, and increased service reliability. Market growth represents the highest-level performance impact of collaboration, as effective integration, innovation, and service quality enable firms to serve wider markets, meet customer expectations more consistently, and expand their competitive reach. Market growth emerges entirely as a dependent outcome, relying on the maturity of all underlying strategic, tactical, and operational enablers.

The TISM model also highlights several transitive relationships, where lower-level enablers influence higher-level outcomes through multiple intermediate pathways. For example, information sharing affects process efficiency not only directly but also through decision synchronization. Similarly, long-term partnership orientation shapes market growth through a chain of interactions involving knowledge creation, communication, innovation, and service quality. These transitive links emphasize the cumulative and interconnected nature of collaboration development.

Overall, the findings reveal that collaboration between 3PLs and manufacturers is fundamentally rooted in strong strategic alignment and long-term relational commitment. These drivers activate a series of tactical mechanisms—such as incentives, information, resources, and coordinated decisions—that gradually build operational excellence. This operational excellence then translates into improved service quality, enhanced innovation, and better process performance, which ultimately yield higher returns and increased market growth. The hierarchical TISM model provides managers with a clear roadmap for strengthening collaboration initiatives by focusing resources and attention on the enablers that exert the greatest influence on the collaborative supply chain structure.

Managerial Implications

The findings of this study offer clear managerial guidance for strengthening collaboration between 3PL providers and manufacturers. The TISM model shows that successful collaboration is built on a strong strategic foundation; therefore, managers must prioritize establishing strategic goal alignment and a long-term partnership approach before focusing on operational improvements. This requires developing shared performance metrics, transparent governance structures, and joint planning frameworks that encourage commitment and reduce opportunistic behavior. Managers should also pay close attention to incentive alignment and joint knowledge creation, as these elements

convert strategic intent into consistent collaborative behavior. Implementing fair incentive systems, shared learning platforms, and cross-functional collaboration teams can enhance mutual understanding and foster trust.

On the tactical side, integrating information systems and enabling seamless information and resource sharing are essential for improving visibility and responsiveness. Investing in real-time data exchange, shared logistics assets, and standardized communication interfaces will help streamline coordination and reduce delays. As the collaboration matures, synchronized decision-making and structured communication become critical for managing variability and uncertainty in the supply chain. Managers should adopt joint forecasting, collaborative scheduling, and routine review meetings to ensure operational alignment. The model also highlights that business synergy, process efficiency, innovation, and service quality consistency are significant pathways through which collaboration generates value. Managers should actively pursue co-development projects, joint process improvements, and integrated service offerings to capitalize on these opportunities. Ultimately, improved collaboration enhances return on investment and drives market growth, showing managers that investing in relational and operational enablers is key to achieving competitive advantage in today's demanding supply chain environment.

CONCLUSION

This study develops a hierarchical TISM model to understand how key enablers influence collaboration between 3PL providers and manufacturers. The model reveals that strategic goal alignment and long-term partnership orientation form the foundation of effective collaboration, driving tactical elements such as incentive alignment, information sharing, joint knowledge creation, and coordinated decision-making. These, in turn, strengthen operational outcomes like process efficiency, innovation, and service quality, which ultimately enhance return on investment and market growth. The MICMAC analysis further classifies the enablers into driving, linkage, dependent, and autonomous categories, helping managers identify which factors require priority attention. Overall, the study demonstrates that strong 3PL–manufacturer collaboration depends on a combination of strategic commitment, integrated processes, and open communication. These insights provide a structured pathway for organizations to build more efficient, responsive, and competitive supply chain partnerships. Future research can expand this framework using quantitative validation or by examining the role of digital technologies in enhancing collaborative performance.

To strengthen collaborative supply chains further, companies require continued managerial commitment, investment in digital integration, development of shared capabilities, and supportive organizational policies. This study provides valuable insights into how collaboration can be systematically developed, sustained, and leveraged to improve supply chain performance. Future research may extend this work by incorporating quantitative validation across different industry sectors, exploring digital collaboration technologies, or evaluating the

impact of emerging logistics models on long-term strategic partnerships between 3PLs and manufacturers...

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