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Trim the fat, gain the edge: lean supply chain activities for cost reduction and competitive advantage

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ABSTRACT

This research investigates the interrelationships between lean supply chain activities (LSCA), supply chain cost reduction (SCCR), and competitive advantage (CA) among Iraqi food and beverage SMEs. This study assessed the moderating effect of information technology (IT) on the relationship between LSCA and SCCR, and developed new measurement scales for both LSCA and SCCR. Both resource-based view (RBV) and transaction cost economics (TCE) theories served as the underpinning theories of this study. Survey data collected from 375 SMEs were analyzed by Structural Equation Modelling (SEM) using SmartPLS4 software for hypothesis testing. The following key results were obtained: (1) the significant influence of LSCA and SCCR on CA; (2) the significant and positive influence of LSCA on SCCR; (3) SCCR as the mediator of the relationship; (4) IT capabilities as the moderator in the relationship between LSCA and SCCR. This study empirically proved the mediating role of SCCR and the moderating role of IT capabilities within the context of developing countries, as well as how LSCA can enhance CA, particularly for Iraqi food and beverage SMEs. This study presents valuable insights on LSCA, SCCR, and IT capabilities for enhanced CA, which would significantly benefit SME owners and managers. However, the cross-sectional design and sector-specific focus limit the generalizability of the findings, underscoring the need for future longitudinal and cross-sectoral research to enhance broader applicability and insight.

1. Introduction

Small and medium enterprises (SMEs) are key economic players that stimulate economic growth and create job opportunities (Kato et al., 2024; Achmad and Wiratmadja, 2025). However, SMEs encounter intense competition, limited resources, supply chain disruptions, and other challenges (Abdeldayem and Aldulaimi, 2023; Liu et al., 2024). SMEs in the Middle East and North Africa (MENA) region (Otman, 2021), especially of those in the Iraqi food and beverage industry, are also similarly affected (Mohammad and Oduoza, 2020; Ali and Nazmi, 2023; KAPITA, 2023). These SMEs have lower competitive advantage (CA) against lower-priced imported food goods (GIZ, 2023), resulting in lower revenues (KAPITA, 2023; Alhalawi and Dammak, 2024). Research indicates that SME performance declines and new business difficulties have prompted an unprecedented demand for sustainable business practices during recent times (Rahman et al., 2025). Modern supply chain strategies need immediate attention according to research from Zimmermann et al. (2020), Garcia-Buendia et al. (2023), and Kavota et al. (2024) as well as the requirement to determine potential factors behind Iraqi SMEs' competitive advantage (Kareem et al., 2021).

Supply chain management becomes more efficient when lean principles are integrated because it produces higher CA through lower production costs alongside minimal waste creation and improved operational efficiency, flexibility, and quality (Moyano-Fuentes et al., 2019; Anvari, 2021; Garcia-Buendia et al., 2023). Moreover, numerous research papers, including Nimeh et al. (2018), Papageorgiou et al. (2020), Kapaj (2022), Garcia-Buendia et al. (2023), Rossini et al. (2023), and Tariq et al. (2023), have established the growing research interest

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toward the positive relationship between LSC and CA. Contrary evidence emerged from Staedele et al. (2019), Musa (2022), and Aripin et al. (2023), and other researchers, including Kusmantini et al. (2018) and Khalfallah and Lakhal (2020), did not find evidence of this relationship. Overall, research studies have neither confirmed nor refuted the conclusions (Abdulameer and Yaacob, 2020) nor the claims of resource-based view (RBV) theory (Manzoor et al., 2021; Khawka et al., 2024), impeding practitioners from investing in lean practices. Additional research needs to pinpoint the results in this domain according to (Khawka et al., 2024; Tavana et al., 2025).

The conflicting results regarding LSCA and CA relationships may stem from varied approaches to focus and assessment (Papageorgiou et al., 2020; Verster et al., 2021; Alhasnawi et al., 2024). The majority of research investigated this connection at the organizational level along with lean management practices (e.g., Cagliano et al., 2006; Moori et al., 2013; Martínez-Jurado and Moyano-Fuentes, 2014; Vanichchinchai, 2019). However, related scholarly works that focused mainly on both the industry level (Khawka et al., 2024) and the supply chain scope (Singh and Pandey, 2015; Marodin et al., 2017; Moyano-Fuentes et al., 2019; Saudi et al., 2019; Rossini et al., 2023) remain sparse. The inconclusiveness may also stem from two other factors: individuals' misunderstanding on lean activities while lacking experience in their impact on performance indicators and CA, especially among SMEs (Pearce et al., 2023) and inadequate measurement scales that fail to validate the effectiveness of LSCA (Moyano-Fuentes et al., 2019; Garcia-Buendia et al., 2023; Piotrowicz et al., 2023; Dahinine et al., 2024). Furthermore, Kosasih et al. (2023a), along with Kosasih et al. (2023b) and Khawka et al. (2024) acknowledged the requirement to build an implementable model for lean adoption that works effectively in SMEs. In addition, very few studies have examined mediating and moderating mechanisms underlying this relationship, such as supply chain cost reduction (SCCR) or IT capabilities, that could clarify when and how LSCA leads to improved outcomes (Garcia-Buendia et al., 2021; Nguema et al., 2022; Khawka et al., 2024). To bridge these gaps, this study proposes an integrative model incorporating SCCR as a mediator and IT capabilities as a moderator, while developing new measurement scales for LSCA and SCCR. By applying this model within Iraqi food and beverage SMEs, the study provides a context-specific explanation that helps reconcile previous inconsistencies and expands the theoretical foundation of LSCA–CA relationships.

Most existing studies (e.g., Vanichchinchai, 2019; Agyabeng-Mensah et al., 2020; Moyano-Fuentes et al., 2021; Nuseir et al., 2024; Komkowski et al., 2025) have primarily focused on lean management rather than offering a comprehensive view on lean supply chain activities, in addition, other studies have examined these activities separately, such as, lean supplier, lean purchasing, lean warehousing, and lean manufacturing (e.g., Powell and Coughlan, 2020; Suresh and Arun Ram Nathan 2020; Pereira et al., 2020; Buer et al., 2021), overlooked a holistic approach by integrating all key lean supply chain activities into a unified framework. This has created a gap in knowledge regarding how specific lean supply chain activities, as opposed to broader lean management, influence competitive advantage across different supply chain contexts and operational levels.

Although several authors have examined cost-related issues within the supply chain (Ramos et al., 2021; Majidi et al., 2022), they have primarily focused on developing frameworks through mathematical models, case studies, or conceptual approaches. For example, most related studies explored mathematical models (e.g., Sutthibutr et al., 2024; Hamta et al., 2023; Kumar and Yadav, 2022), case studies (e.g., Pettersson and Segerstedt, 2013; Postacchini et al., 2016; Benrqya, 2019), and conceptual frameworks (e.g., Pettersson, 2015; Mpwanya and van Heerden, 2017) and predominantly focused on only one type of supply chain cost (e.g., Swenseth and Olson, 2016; Leaven et al., 2017; Trabucco and De Giovanni, 2021), instead of the total supply chain costs (Ramos et al., 2021).

Furthermore, the empirical investigation of the interrelationships between the antecedents and effects of (SCCR) have remained underexplored (Selvaraju et al., 2017; Wang et al., 2020; Nguema et al., 2022). The influence of LSCA on SCCR and the supply chain-centric perspective have been critically overlooked (e.g., Su and Lei, 2008; Mpwanya and van Heerden, 2017; Um et al., 2017; Chandak and Kumar, 2019). After all, it is more cost-effective to optimise the entire supply chain, as compared to the optimisation of individual components (Masoud and Mason, 2016; Marodin et al., 2017; Ramos et al., 2021).

Given the conflicting findings on the relationship between LSCA and CA and the need for further clarification, Khawka et al. (2024) highlighted the need for more studies on this relationship. Furthermore, Kankam and Dza (2023) suggested that the possible mediation and moderation effects may enhance this relationship. In addition, competitive advantage may be influenced by different factors exceeding individual knowledge of lean practices and activities, such as information technology (Pavlović et al., 2019). Recent studies by Mohammed et al. (2023) and Ghazwani and Alzahrani (2024) highlighted the positive influence of IT on CA among SMEs. Similarly, Talukder et al. (2025) revealed that sustainable technology is undoubtedly critical for SMEs in attaining their economic, social, and environmental goals. Notwithstanding, Iraqi food and beverage SME manufacturers have a depressed IT infrastructure (Jabouri and Al-Akili, 2022; Majid et al., 2024). This may be due to the lack of experience and acceptance, unwillingness to share information, ineffective leverage for digitalisation (Khawka, 2015; Hove-Sibanda and Pooe, 2018; Abed, 2022; Mishrif and Khan, 2023; Majid et al., 2024), and the lack of technical skills and resources (Eiriz et al., 2019). Consequently, if Iraqi SMEs desire to enhance their competitiveness and organizational performance, they must promptly consider investing in IT infrastructure (Mohammed et al., 2023; Ghazwani and Alzahrani, 2024). As a key enabler to the pursuit of cost reduction-related CA with the LSC strategy, the choice of IT is also essential (Oliveira-Dias et al., 2022). Moreover, although earlier studies have examined the role of IT (e.g., Tortorella et al., 2019; Pintuma et al., 2020; Amoako et al., 2022), limited studies have investigated its significance in the LSCA-SCCR interplay (Garcia-Buendia et al., 2021; Oliveira et al., 2022; Khawka et al., 2024) and influence on CA within the context of lean supply chain (Khawka et al., 2024).

Furthermore, it is clear from previous studies that the relationship between lean supply chain and cost reduction remains inconclusive (Tortorella et al., 2018b; Abdulameer and Yaacob, 2020; Garcia-Buendia et al., 2024). While some studies found a positive relationship (e.g., Nimeh et al., 2018; Rossini et al., 2023), others have reported insignificant associations (e.g., Staedele et al., 2019; Aripin et al., 2023). In addition, despite the widespread coexistence of IT and lean in business environments, findings on their interaction in practice have remained lacking and present unclear results (Buer et al., 2018; Marodin et al., 2023). Evidently, more studies are necessary to explore the moderating effect of IT in this relationship (Garcia-Buendia et al., 2021, 2023; Khawka et al., 2024; ALShanti et al., 2025).

The above discussion raised questions on factors that contribute to improving CA, the influence of LSCA on SCCR in enhancing CA, and the role of IT in the relationship between LSCA and SCCR. With that, focusing on Iraqi food and beverage SMEs, this study aimed to examine the interrelationships of LSCA, SCCR, and CA. It also assessed the mediating role of SCCR and the moderating role of IT capabilities and developed new measurement scales for LSCA and SCCR. The introduction of new measurement scales for LSCA and SCCR provided more in-depth insights on these complex dynamics within the supply chain network. Unlike other prior studies, this study provided empirical evidence on the mediating role of SCCR in the relationship between LSCA and CA and the moderating role of IT capabilities in the relationship between LSCA and SCCR, which expanded the current literature on the complex dynamics of LSCA, SCCR, and CA. Addressing Khawka et al.'s (2024) and AL Shanti et al.'s (2025) recommendation of expanding the investigation to overlooked industries, as well as the lack of related empirical studies on SMEs from developing countries, especially of those

in the MENA region, this study explored Iraqi food and beverage SMEs, which provided better clarity on these interrelationships. The adoption of RBV and TCE theories in this study expanded the reach of these theories. By examining how LSCA and IT capabilities—viewed as firm-specific strategic resources in RBV—interact with SCCR to affect CA, this study responds to gaps in theory-based research in developing contexts. Simultaneously, the use of TCE provides a robust lens to understand how cost-efficient transactions across the supply chain mediate the CA outcomes of lean implementation, especially in SMEs operating under uncertainty and limited resource environments.

Although the increasing body of literature on LSCM field, several key research gaps remain. First, there is a lack of empirical evidence exploring the interrelationships between LSCA, SCCR, and CA, especially within SMEs in emerging economies, where operational environments and constraints differ significantly from developed economies. Second, most prior studies have focused on individual cost elements rather than adopting a total supply chain cost perspective, which limits their ability to evaluate true cost reduction benefits and limits the broader applicability of their findings. Third, the moderating effect of IT capabilities on the LSCA–SCCR relationship remains underexplored, although it is recognized as a strategic enabler. Fourth, there is an absence of appropriate measurement scales to empirically validate LSCA and SCCR, especially within SMEs in developing countries, making it difficult to generalize findings and cross-contextual comparisons. Finally, there is a lack of integrated, theory-based models using RBV and TCE in a unified framework to explore how specific internal resources and cost efficiencies contribute to enhancing competitive advantage (Neves et al., 2014; Zhu, 2024; Mailani et al., 2024; Komakech et al., 2025). Therefore, the present study addresses these gaps by empirically investigating the interrelationships between LSCA, SCCR, and CA among food and beverage SME manufacturers. In addition, this study introduces SCCR as a mediator and IT capabilities as a moderator in these relationships. Furthermore, it develops new measurement scales for LSCA and SCCR and applies an integrated RBV–TCE framework to offer novel theoretical and empirical insights in emerging economies.

2. Literature review and development of hypotheses

2.1. Resource-based view (RBV) theory

The RBV theory, which posited that a firm's unique and valuable resources and capabilities contribute to its CA (Barney, 1986; Alshawawreh et al., 2024), has been widely used to assess the influence of internal firm characteristics on CA (Battisti et al., 2022). Internal resources and capabilities, including LSCA (Kankaew et al., 2021; Minguela-Rata et al., 2024), are the main sources of CA within this strategic management framework (Madhani, 2010). The integration of lean principles as part of the supply chain involves more than the focal firm's resources, extending to those of numerous agents within the chain. The collaborative operation of resources enhances the efficiency of all supply chain agents, which substantially improves the focal firm's CA and performance (Minguela-Rata et al., 2024).

Other valuable resources include IT assets, such as proprietary software, data analytics capabilities, customer relationship management (CRM) systems, and advanced infrastructure (Adama et al., 2024). The integration of IT can reduce supply chain costs and improve supply chain profitability (Loon et al., 2018; Sharma et al., 2024). With respect to the RBV theory, this study assesses IT capabilities as strategic resources that enhance supply chain performance and contribute to competitive advantage. RBV posits that valuable, rare, inimitable, and non-substitutable (VRIN) resources can generate sustained performance outcomes (Wernerfelt, 1984). This broader resource perspective becomes clear in the study by Garad and Khalifa (2024), which emphasized that environmental management practices and green innovation contribute directly to financial and environmental performance, particularly when embedded within a firm's strategic resource base. Referring to Garad and Khalifa's (2024) findings regarding green innovation, using open innovation as a broader framework will pave the way for the organisation's innovation development and competitiveness (Shahin et al., 2025).

In this regard, open innovation is considered a crucial strategy for SMEs, particularly in emerging economies, to access external knowledge, develop new products, and increase market share, thereby boosting their competitive advantage, especially in light of the huge digital transformations and associated pressures (Tran et al., (2024); Yu et al., 2025). Nowadays, the enormous spread of digital technologies forces SMEs to face an external environment distinguished by complexity and velocity (Costa et al., 2023), particularly in a highly competitive market like Iraq. Here, the role of open innovation stands out; instead of building everything in-house, SMEs can adopt/adapt developed solutions externally through collaboration with different parties, being open to the world, to merge external knowledge, ideas, and technologies with internal innovation resources to save costs and time (Leitão et al., 2020; Sabando-Vera et al., 2022; Robertsone and Lapiņa, 2023; Shahin et al., 2025). Simultaneously, open innovation through internal and external activities is primary for the competitive advantage of SMEs (Shahin et al., 2025). Therefore, interaction with external knowledge networks enables SMEs, especially in developing economies, to accelerate the pace of its business, and overcome massive challenges, such as a lack of resources, low research and development capacity, and poor IT infrastructure, while retaining a sustainable competitive advantage (Vera et al., 2023; Shahin et al., 2025).

2.2. Transaction cost economics (TCE) theory

The TCE theory, which elucidated the influence of transaction cost on organisational behaviour and structure, is extensively used in operations and supply chain management research (Ketokivi and Mahoney, 2020). This theory posited that costs should be reduced for higher organisational efficiency and competitiveness (Yuwono et al., 2024). Theoretically, the right mechanism can reduce the incurred costs (Ketokivi and Mahoney, 2020), stimulating higher CA (Kwon et al., 2011). Transaction in this context denotes the exchange of information, goods, or services between the production stages (Williamson, 1975, 1985)—for example, between value-adding stages within the firm and any purchase made by a buyer from its supplier (Williamson, 1985). In this approach, the cost of the market pricing goods or services is considered, instead of a fixed price (Coase, 1937). Costs are the most crucial feature of CA in the LSC (Konecka, 2010; Papageorgiou et al., 2020). This approach introduces better flexibility and supports the implementation of LSC (Khorasani et al., 2020). Marhoon et al. (2019) underscored SCCR as a key driving factor of CA. Considering the involvement of transactions within a supply chain (Yoo et al., 2019), the TCE theory was deemed fitting to be integrated into this study's theoretical framework, along with the RBV theory.

2.3. Lean supply chain activities

LSC denotes the adoption and management of lean management (LM) principles and practices in the supply chain to reduce costs and waste by strategically addressing individual customers' needs (Núñez-Merino et al., 2020; Singh and Modgil, 2023) at lower costs and higher efficiency, boosting CA (Ping et al., 2014; Rossini et al., 2023; Vaezinejad, S., & Schniederjans, 2024). The expansion of LSC requires comprehensive understanding of its key activities and underlying philosophy.

Accordingly, there are six LSCA: (1) "lean supplier" that refers to the utilisation of lean manufacturing principles by the supplier for process optimisation, waste reduction, and efficient product delivery (Wu, 2003); (2) "lean purchasing" that refers to the achievement of cost savings and production efficiency through reduced inventory levels (Wilson and Roy, 2009; Suresh and Arun Ram Nathan 2020); (3) "lean

manufacturing" that refers to resource optimisation through best practices and continuous improvement in the production process (Womack et al., 1990; Buer et al., 2021); (4) "lean warehousing" that refers to the significant optimisation of the distribution area by minimising waste, maximising available space, enhancing productivity, and addressing customers' demands (Abushaikha et al., 2018); (5) "lean transportation" that refers to efficient logistics and transportation processes at lower costs and improved delivery (Villarreal et al., 2016; Gomes et al., 2024); (6) "lean customer" that involves partnerships with clients for improved supply chain at lower costs and reduced lead times (van Assen, 2021; Barasa, 2022).

The significant and positive relationship between LSC and CA was empirically demonstrated in studies (e.g., Papageorgiou et al., 2020; Anvari, 2021; Ariadi et al., 2021; Klein et al., 2022; Garcia-Buendia et al., 2023). Studies have also demonstrated the roles of LSC in reducing waste and costs and improving efficiency (e.g., Carvalho et al., 2017; Vanichchinchai, 2019; Moyano-Fuentes et al., 2021; Garcia-Buendia et al., 2021; Hardcopf et al., 2021; Rossini et al., 2023). Thus, this study hypothesised the following:

H1. : LSCA positively influence CA.

H2. : LSCA positively influence SCCR.

2.4. Supply chain cost reduction and competitive advantage

According to the TCE theory, costs can be reduced by managing the transactions involved (Pirttilä et al., 2020). In other words, transaction costs are economised (Williamson, 1985) for higher CA (Lapinskaitė and Kuckailytė, 2014; Marhoon et al., 2019). The primary concern of supply chains is cost reduction given its significant influence on profitability (Grosse-Ruyken, 2009).

There are four types of supply chain costs that directly influence a firm's competitiveness: (1) purchasing cost (total expenses of acquiring goods and services from external sources) (Ibrahim, 2021); (2) manufacturing costs (various plant-level expenses, including production, product shortage, inventory, labour-related, and overhead production costs) (Pettersson and Segerstedt, 2013; Sutthibutr et al., 2024); (3) inventory cost (total expenses of ordering, storing, and managing inventory and paperwork management) (Hemant and Shafighi, 2023); (4) transportation costs (inbound and outbound transportation expenses and other logistical costs) (Damodaram et al., 2022).

The relationship between SCCR and CA is well-established in literature. For instance, Kannabiran and Sundar (2011) reported a strong correlation between SCCR and competitive marketing. Likewise, Al-Barghuthi et al. (2020) observed the achievement of CA and rationalisation of strategic cost management through cost reduction. In other words, cost reduction enhances financial performance and supports more strategic resource allocation. Thus, the following hypothesis was tested in this study:

H3. : SCCR positively influence CA.

2.5. The mediating role of supply chain cost reduction

The robustness of the LSC approach in enhancing supply chain performance and CA has been widely acknowledged (Khawka et al., 2024). However, solely relying on LSC to achieve CA is implausible (Tortorella et al., 2018a) given the substantial influence of costs on CA (Konecka, 2010; Papageorgiou et al., 2020). The TCE theory posited the need to reduce costs for higher organisational efficiency and competitiveness (Yuwono et al., 2024), where SCCR plays a crucial role (Papageorgiou et al., 2020). Furthermore, cost reduction maintains reasonable supply chain costs, directly influencing CA (Marhoon et al., 2019; Tran et al., 2025). Supply chain significantly influences the final product cost, making it crucial to continuously improve the supply chain processes to ensure lower overall costs (Lapinskaitė and Kuckailytė, 2014; Tran et al., 2025).

The improved efficiency and flexibility of all supply chain stages through LSC have established this approach as a strategic means to boost competitiveness (Moyano-Fuentes et al., 2019; Garcia-Buendia et al., 2023). LSCM effectively minimises costs and enhances efficiency and customer satisfaction, which collectively contribute to higher CA (Baysan et al., 2013; Ping et al., 2014; Garcia-Buendia et al., 2023; Rossini et al., 2023; Khawka et al., 2024; Schniederjans, (2024)).

The positive relationship between LSCM and CA was demonstrated in prior studies (e.g., AL-Shboul et al., 2018; Nimeh et al., 2018; Papageorgiou et al., 2020; Budianto et al., 2021). Besides that, the significant relationship between LSC and cost reduction was noted in numerous prior studies (e.g., Cvetić et al., 2021; Al Saadi and Amuthakkannan, 2024). Studies and theories have suggested that effective management and reduction of transaction costs in the supply chain operations can enhance performance and CA. Thus, the following hypothesis was proposed:

H4. : SCCR mediates the relationship between LSCA and CA.

2.6. The moderating role of information technology capabilities

IT is fundamental in enhancing communication among supply chain partners (Abdulameer and Yaacob, 2020) and sharing pertinent information to reduce uncertainties and environmental complexities for better functioning and satisfactory outcomes of LSC (Kisperska-Moron and De Haan, 2011). In order to achieve its primary goal of strategic cost reduction, LSC requires accurate and timely information to reduce inventory (Khawka et al., 2024). The strategic integration of IT with the upstream and downstream of the supply chain (Li and Zhao, 2024) can reduce inventory and enhances quality at lower costs and reduced lead times, yielding enhanced supply chain performance (Banerjee, 2015; Wei et al., 2022).

There are numerous definitions of IT capabilities. Awamleh and Ertugan (2021) defined IT capabilities as the ability to mobilise and deploy IT-based resources in support of and for the enhancement of business strategies and work processes. Meanwhile, Zeng and Lu (2021) identified IT capabilities based on the following dimensions, which were deemed fitting for the current study to employ within the context of supply chain (Kyagante et al., 2024): (1) IT talent capabilities (employees' skills in self-learning and using IT and motivation to execute IT-related work) (Kyagante et al., 2024); (2) IT infrastructure capabilities (a firm's ability to deploy hardware platforms and related software systems) (Lu and Ramamurthy, 2011); (3) IT internal and external communication capabilities (how IT systems are deployed to optimise the IT systems for collaboration and communication) (Kyagante et al., 2024).

The significant influence of IT on SCCR was documented in most prior studies (e.g., Garcia-Buendia et al., 2023; Rossini et al., 2023). The TCE theory posited reduced transaction costs through IT that would improve information flow and reduce inefficiency in the supply chain operation (Li and Zhao, 2024; Yuwono et al., 2024). As a universally accepted as an effective means to boost efficiency (Zawawi and Wahab, 2018), IT has been demonstrated to significantly moderate green supply chain management practices (Alkasassbeh, 2024), firm performance (Rittiboonchai et al., 2021), and supply chain performance (Tortorella et al., 2018a). However, Garcia-Buendia et al. (2021) and Oliveira et al. (2022) noted the lack of studies on the moderating role of IT on lean supply chain and performance outcomes like SCCR. IT plays a pivotal role of enhancing different aspects of business operations and performance outcomes, including the dynamics of LSCA, SCCR, and CA. Hong et al. (2024) highlighted that Cloud ERP enables cost-efficient operations and process optimisation, especially for resource-constrained SMEs. Thus, this study hypothesised the following:

H5. : IT capabilities positively moderate the relationship between LSCA and SCCR.

2.7. Competitive advantage

An organisation demonstrates a competitive advantage by creating greater economic value than its competitors (Tj et al., 2025), hence supporting the argument that internal competencies, such as lean supply chain activities, are crucial for attaining competitive advantage. CA is a favourable outcome of LSCA that involve cost reduction, waste elimination, and improved quality (Papageorgiou et al., 2020; Garcia-Buendia et al., 2023; Khawka et al., 2024). There are various definitions of CA, which are conceptually similar (Shebeshe and Sharma, 2024). Kroes and Ghosh (2010) defined CA as a firm's ability to surpass its competitors.

Accordingly, there are five key dimensions of CA (Li et al., 2006; Mukhsin and Suryanto, 2022; Li et al., 2024; Mustafi et al., 2024; Shebeshe and Sharma, 2024; Tran et al., 2024). Firstly, Li et al. (2024) defined price/cost as a firm's ability to compete against its major competitors based on low pricing. Secondly, Sánchez Santiago et al. (2012) and Gillani et al. (2020) defined quality as the ability of a product or service to consistently meet customers' expectations, which is regarded as the main drive of competitiveness. Thirdly, Tarigan et al. (2021) defined delivery dependability as the extent of a firm delivering a product on time according to customers' needs. Fourthly, Najafi-Tavani et al. (2018) defined product innovation as a firm's ability to introduce new products or services to satisfy evolving customers' needs or to employ new technologies for commercial use. Lastly, Kim et al. (2024) defined time to market as the time taken to develop and launch a new product. Given the existing consensus in literature on these dimensions, Li et al.'s (2006) five dimensions were employed for a comprehensive measurement of CA in this study.

Several scholarly works have confirmed a direct LSC-CA relationship (e.g, Ariadi et al., 2021; Rossini et al., 2023; Garcia-Buendia et al., 2023). LSC improves operational efficiency, flexibility, competitiveness, and performance outcomes (Ahmed and Huma, 2021). It also reduces costs and the proportion of defective units in production and improves quality levels (Sharma et al., 2022). Furthermore, LSC enhances customers' satisfaction and communication, which effectively boost CA (EL-Khalil, 2018). Hence, LSCM helps firms to achieve CA by improving their ability to meet customers' needs and demands, reducing costs, and increasing efficiency (Khawka et al., 2024). The RBV theory supported the role of LSC as a means to achieve CA, which was considered in this study. Figure 1 presents the research model and conceptual framework of this study.

3. Methodology

3.1. Research design, sample, and procedure

This quantitative study employed the cross-sectional design with a deductive approach. In this case, the survey method that involves a questionnaire survey is typically considered (Kumari and Ajward, 2023; Zaidan et al., 2023; Atiyah et al., 2024), which was employed in this study. The survey involved key decision-makers of food and beverage SMEs across 18 Iraqi governorates. This selection ensured the participation of individuals with comprehensive knowledge on the supply chains and logistics of SMEs. With that, respondents were conveniently sampled. Informed consent was first obtained from each respondent, which ensured only voluntary participation, and anonymity was strictly ensured throughout the study (Khoa, 2023). Reminders were provided to minimise non-response risk (Alhasnawi et al., 2024). G*Power was utilised to determine the required minimum sample size for this study, which revealed at least 88 respondents at a power of 0.8 (Hair et al., 2017). According to Hair et al., 2017, it is recommended to go for a sample size larger than the number of indicated structural paths or a sample size equal to or more than the number of indicators by 10 times. This study sampled 375 respondents, which met the minimum sample size requirement.

3.2. Measurement and instrument development

Respondents were first briefed on the purpose of the study, ensuring them to provide appropriate responses in the survey. The survey required all respondents to provide basic demographic information. The selection of survey items was informed by well-established literature to ensure both content validity and contextual relevance to the Iraqi SME setting. For lean supply chain activities (LSCA), items were newly developed based on lean principles documented in studies such as Womack et al. (1990), Wu (2003), Villarreal et al. (2016), and Abushaikha et al. (2018). These items reflect core LSCA dimensions—such as waste elimination, continuous improvement, demand-driven replenishment, and supplier integration—thus effectively capturing the strategic and operational essence of lean supply chains. For SCCR, items were structured around four major cost dimensions: purchasing,

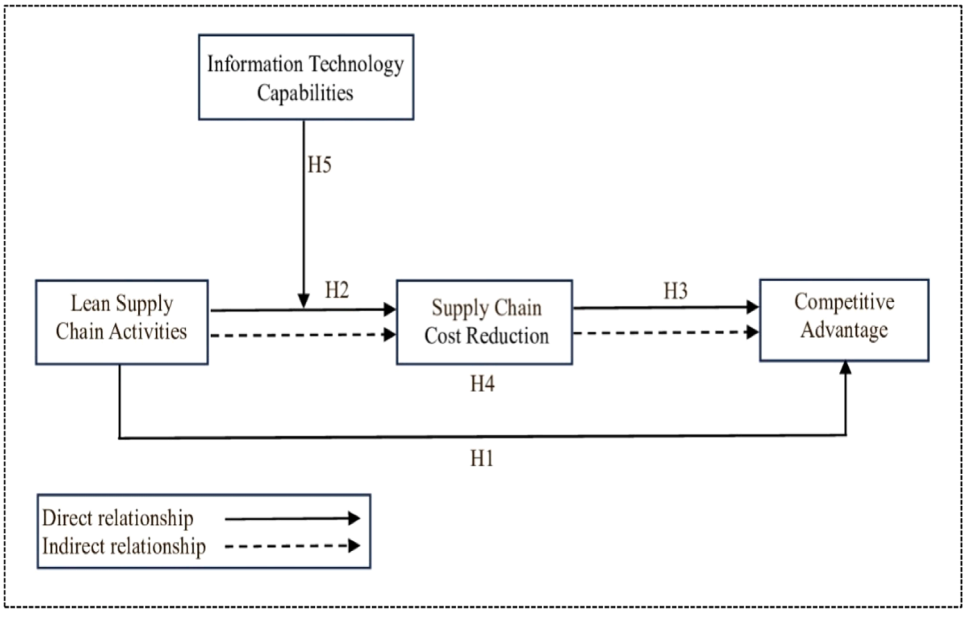

Figure 1. Research Framework.

manufacturing, inventory, and transportation costs, based on works such as Pettersson and Segerstedt (2013), Pettersson (2015), Ibrahim (2021), Ramos et al. (2021), and Maharani et al. (2022), to capture total supply chain cost factors as per TCE theory. These were validated through experts' input to ensure they reflect tangible financial outcomes attributable to LSCA.

The construct of IT capabilities was measured using items adapted from Zeng and Lu (2021), which include four distinct yet interrelated dimensions: IT talent (skills and motivation), IT infrastructure (hardware/software availability), internal communication (systems for intra-firm coordination), and external communication (IT use in inter-firm collaboration). These dimensions capture both the technical and relational competencies of IT capabilities, consistent with the Resource-Based View (RBV), which posits that such embedded capabilities drive performance. For competitive advantage (CA), items were adapted from Li et al. (2006), which define CA in terms of five competitive priorities: price/cost, quality, delivery dependability, product innovation, and time to market. These dimensions are widely recognized in operations and strategic management literature as holistic indicators of a firm's ability to outperform competitors.

A translation specialist was appointed to translate the instrument from English to Arabic, and another expert was appointed to rephrase the same instrument in English to ensure that the instrument reflected the intended meaning for which it was translated (Alhasnawi et al., 2023). All constructs were measured according to a five-point Likert scale, with the endpoints of "strongly disagree" (1) and "strongly agree" (5). As part of the pre-test process, the validity and comprehensibility of the developed instrument were later reviewed by five management academics and four SME managers in the food and beverage industry (two with a PhD and two with a Master's degree). Furthermore, a pilot study was conducted with 43 SME owners and managers prior to the actual data collection. The results of the pilot study revealed Cronbach's alpha of above 0.7 for all constructs, reflecting high internal consistency. The survey items for each construct are presented in Appendix A.

3.3. Descriptive profile of respondents

Descriptive analysis was performed using IBM SPSS. Referring to Table 1, most of the respondents (86.9 %) were men. This discrepancy indicated a significant gender gap in Iraqi food and beverage SMEs, which may be attributed to a complex interplay of various factors. Firstly, considering the cultural structure of Iraqi society, most women tend to work in the public sector, such as education, banking, healthcare, and the judiciary, avoiding a career in private business. The acquired sample reflected the typical demographic distribution of Iraqi SME owners given the study's focus on owners and managers of SMEs in Iraq. Secondly, despite the fair treatment, this imbalance may reflect the disparities in women's willingness or ability to participate, rather than reflecting intentional exclusion from the study.

Most of the respondents in this study were between the age of 41 and 45 years (26.1 %) and reported attaining Bachelor's degree (36.3 %). Small enterprises (61.9 %) dominated the organisational landscape in this study, with a significant proportion of respondents holding managerial (34.9 %) or assistant managerial (37.9 %) positions. Most of the respondents had one year to five years of work experience (38.1 %), followed by those with six to 10 years of work experience (27.2 %). The majority of businesses was established for over five years (69.3 %), indicating a mature business environment among the respondents in this study.

3.4. Common method bias

The collection of data from the same reference may pose critical issue of common method variance. Addressing that, this study employed Podsakoff et al. (2012) recommendation, which involved a procedural treatment and a statistical treatment of knowledge. The first method serves as a preventive strategy that includes anonymity of respondents, special reverse clauses (retranslation), and separation of the sources of the independent and dependent variables. The participating respondents were assured of their anonymity and convinced that there were no right or wrong answers to the questions in the survey (Leong et al., 2020). The second method involved Harman's single-factor test for statistical control. Exploratory factors analysis (EFA) was conducted using IBM SPSS. The results revealed that the accounted variance value of 36.41 %, which was below the established threshold of 50 % of variance explained. Thus, no critical issue of common method variance was concluded.

Table 1
Demographic profile of respondents.

Categories	Demographic Characteristics	Frequency (n = 375)	Percentage (%)
Gender	Male	326	86.9
	Female	49	13.1
Age (years)	18–24	1	0.3
	25–30	25	6.7
	31–35	34	9.1
	36–40	71	18.9
	41–45	98	26.1
	46–50	84	22.4
	51 and above	62	16.5
Education level	None	3	0.8
	Primary school	79	21.1
	Secondary school	85	22.7
	Diploma	68	18.1
	Bachelor's degree	136	36.3
	Master's degree	2	0.5
	PhD	2	0.5
Organisation type	Small enterprise	232	61.9
	Medium enterprise	143	38.1
Position	Owner	102	27.2
	Manager	131	34.9
	Assistant manager	142	37.9
Work experience (years)	Less than 1	4	1.1
	1–5	143	38.1
	6–10	102	27.2
	More than 10	126	33.6
Years of business established	Less than 6 months	1	0.3
	6 months to less than 1 year	2	0.5
	1 year to less than 5 years	112	29.9
	5 years and above	260	69.3

4. Results

4.1. Measurement model

Based on Hair et al., (2017) recommendation, factor loadings, average variance extracted (AVE), and composite reliability (CR) were assessed in this study to evaluate convergent validity. The obtained results are summarised in Table 2. Factor loadings refer to the correlation between the observed variables (items) and their underlying latent constructs. The recorded factor loadings of between 0.730 and 0.928, which exceeded the threshold of 0.7, demonstrated strong to very strong associations. The results indicated the robustness of the indicators of their respective constructs. However, LP1, LP2, LS8, LM5, PC1, and ITIC3 recorded loadings of below the recommended value of 0.5.

Meanwhile, AVE refers to the amount of variance captured by a construct relative to the variance due to measurement error. The recorded values of AVE ranged from 0.620 to 0.809, which exceeded Fornell and Larcker's (1981) recommended minimum threshold of 0.5. In other words, all constructs demonstrated satisfactory convergent validity. Additionally, the recorded values of CR ranged from 0.711 to 0.901, which exceeded 0.7. Thus, high factor loadings and satisfactory AVE and CR reaffirmed the internal consistency and discriminant

Table 2
First-order constructs: Factor loadings, CR, and AVE.

Constructs	Number of Items	Factor Loadings	Composite Reliability (CR)	Average Variance Extracted (AVE)
Lean purchasing	6	0.819 – 0.873	0.742	0.691
Lean supplier	7	0.793 – 0.859	0.852	0.712
Lean transportation	8	0.783 – 0.865	0.901	0.725
Lean manufacturing	7	0.856 – 0.887	0.711	0.719
Lean warehousing	8	0.749 – 0.769	0.825	0.709
Lean customer	8	0.761 – 0.876	0.820	0.640
Purchasing cost	5	0.804 – 0.902	0.833	0.772
Inventory cost	6	0.749 – 0.805	0.854	0.689
Manufacturing cost	6	0.884 – 0.889	0.754	0.763
Transportation cost	6	0.758 – 0.809	0.754	0.763
IT talent capabilities	4	0.831 – 0.928	0.787	0.682
IT infrastructure capabilities	3	0.730 – 0.921	0.815	0.696
IT internal communication capabilities	4	0.899 – 0.905	0.843	0.809
IT external communication capabilities	4	0.805 – 0.840	0.742	0.693
Price/cost	4	0.740 – 0.849	0.781	0.670
Quality	5	0.812 – 0.883	0.812	0.691
Delivery dependability	4	0.741 – 0.830	0.802	0.787
Product innovation	4	0.769 – 0.915	0.827	0.764
Time to market	4	0.869 – 0.925	0.751	0.620

validity of all constructs. As for the evaluation of discriminant validity, heterotrait-monotrait (HTMT) criterion was employed. The recorded values (Table 3) were lower than the recommended threshold of 0.85 (Henseler et al., 2015), providing evidence of discriminant validity.

The assessment of measurement model ensued for higher-order constructs (Hair et al., 2017). Based on Hair et al. (2014) definition, LSCA, SCCR, IT capabilities, and CA were all type-1 reflective-reflective higher-order constructs. A two-stage testing procedure was employed. Referring to Hair et al. (2014) suggestion, only the results of convergent validity (Table 4) were reported. The obtained results of factor loadings (> 0.7), CR (> 0.7), and AVE (0.5) exceeded Hair et al. (2019) recommended thresholds, which demonstrated the validity and reliability of all second-order constructs. Thus, the measurement validity of the current model using second-order constructs was deemed valid.

Prior to SEM, EFA was conducted. Table 5 details the results of EFA for LSCA and SCCR. Each item of the construct was labelled accordingly. For instance, under LSCA, lean customer (LC) consisted of eight items. Thus, these items were labelled as LC1 up to LC8. All six factors of LSCA and four factors of SCCR exceeded the value of 1. Only five items of LSCA (LC6, LM2, LM4, LP3, and LS7) and four items of SCCR (PC5, IC1, IC2, MC1), which recorded loadings of below 0.4, were discarded. The derived correlation matrix revealed coefficient values of 0.70 and above, which indicated the strong correlations of all items with their corresponding constructs. As shown in Table 6, LSCA recorded Kaiser-Meyer-Olkin (KMO) value of 0.866, whereas SCCR recorded KMO value of

Table 3
Heterotrait-monotrait ratio (HTMT).

	ITIC	PCO	DD	ITCC	ITEC	IC	ITTC	TMM	LC	LM	LP	LS	LT	LW	MC	PC	PI	TC	QUA
ITIC																			
PCO	0.725																		
DD	0.747	0.240																	
ITCC	0.803	0.457	0.434																
ITEC	0.612	0.297	0.299	0.227															
IC	0.798	0.433	0.348	0.562	0.279														
ITTC	0.651	0.365	0.267	0.347	0.218	0.304													
TMM	0.421	0.150	0.384	0.318	0.168	0.301	0.307												
LC	0.575	0.273	0.499	0.417	0.255	0.408	0.376	0.814											
LM	0.519	0.396	0.383	0.486	0.131	0.336	0.308	0.323	0.650										
LP	0.414	0.140	0.406	0.220	0.279	0.285	0.261	0.688	0.723	0.311									
LS	0.492	0.204	0.444	0.383	0.245	0.361	0.257	0.640	0.725	0.500	0.650								
LT	0.629	0.470	0.479	0.539	0.221	0.388	0.370	0.303	0.471	0.541	0.300	0.366							
LW	0.404	0.338	0.346	0.383	0.125	0.204	0.192	0.150	0.264	0.352	0.130	0.235	0.780						
MC	0.431	0.353	0.361	0.301	0.128	0.258	0.283	0.266	0.357	0.405	0.215	0.229	0.809	0.591					
PC	0.544	0.344	0.407	0.454	0.174	0.393	0.349	0.356	0.476	0.407	0.311	0.427	0.841	0.381	0.446				
PI	0.479	0.454	0.271	0.333	0.256	0.287	0.306	0.112	0.254	0.269	0.192	0.213	0.869	0.533	0.505	0.568			
TC	0.551	0.262	0.478	0.613	0.209	0.305	0.293	0.329	0.455	0.549	0.287	0.342	0.778	0.416	0.415	0.587	0.438		
QUA	0.386	0.365	0.269	0.308	0.261	0.282	0.307	0.199	0.310	0.287	0.310	0.293	0.265	0.397	0.398	0.347	0.218	0.304	

Abbreviations: LP denotes lean purchasing; LS denotes lean supplier; LT denotes lean transportation; LM denotes lean manufacturing; LW denotes lean warehousing; LC denotes lean customer; PC denotes purchasing cost; IC denotes inventory cost; MC denotes manufacturing cost; TC denotes transportation cost; ITTC denotes information technology talent capabilities; ITIC denotes information technology infrastructure capabilities; ITCC denotes information technology internal communication capabilities; ITEC denotes information technology external communication capabilities; PCO denotes price/cost; QUA denotes quality; DD denotes delivery dependability; PI denotes product innovation; TMM denotes time to market.

Table 4
Second-order constructs: Factor loadings, CR, and AVE.

Constructs	Dimensions	Factor Loadings	CR	AVE
Lean supply chain activities	Lean purchasing	0.763	0.915	0.668
	Lean supplier	0.906		
	Lean transportation	0.895		
	Lean manufacturing	0.876		
	Lean warehousing	0.724		
	Lean customer	0.702		
Supply chain cost reduction	Purchasing cost	0.798	0.905	0.701
	Inventory cost	0.746		
	Manufacturing cost	0.875		
	Transportation cost	0.872		
Information technology capabilities	IT talent capabilities	0.887	0.804	0.625
	IT infrastructure capabilities	0.839		
	IT internal communication capabilities	0.852		
	IT external communication capabilities	0.843		
Competitive advantages	Price/cost	0.856	0.911	0.721
	Quality	0.884		
	Delivery dependability	0.704		
	Product innovation	0.847		
	Time to market	0.882		

0.843. Both values exceeded the threshold of 0.60, reflecting sampling adequacy. The results of Bartlett's test of sphericity revealed the value of 0.000 for both constructs, supporting the concept of factorisation.

4.2. Structural model

Following the validation of measurement model, path analysis was conducted to test the proposed hypotheses. In line with Hair et al., (2017) recommendation, inner VIFs, path coefficient estimates, R^2, and f^2, as well as the predictive ability of both Q^2 and $PLS_{predict}$ were assessed. Considering the involvement of several regression analyses for the PLS-SEM computation of path coefficients, this study first examined the presence of multicollinearity. Collinearity issues were examined to ensure they did not affect the regression results (Ng et al., 2022). According to Hair et al., (2017), inner VIF values should be below 5. As shown in Table 7, all recorded inner VIF values were within this acceptable range, indicating no multicollinearity concerns among the predictor constructs. The results further demonstrated the direct significant influence of LSCA on CA (H1: $\beta = 0.348$, $t = 6.116$, $p < 0.01$, $f^2 = 0.128$) and SCCR (H2: $\beta = 0.198$, $t = 2.645$, $p < 0.01$, $f^2 = 0.025$) and the direct significant influence of SCCR on CA (H3: $\beta = 0.207$, $t = 4.191$, $p < 0.01$, $f^2 = 0.045$). The bootstrapping with 5000 subsamples was applied, a non-parametric resampling technique commonly used in PLS-SEM to test the statistical significance of path coefficients and ensure stability of estimates. The bootstrapping results demonstrated the partial mediating effect of SCCR on the significant relationship between LSCA and CA (H4: $\beta = 0.041$, $t = 2.282$, $p < 0.05$). The results also confirmed the moderating effect of IT capabilities on the relationship between LSCA and SCCR (H5: $\beta = 0.124$, $t = 2.132$, $p < 0.05$). Thus, all hypotheses were supported.

The R^2 values of CA and SCCR were 0.421 and 0.525, respectively, which exceeded 25 % and demonstrated a highly acceptable prediction level in empirical research (Gaur and Gaur, 2006). According to Cohen) (1988)), f^2 is often used to assess the relative impact of an exogeneous construct on an endogenous construct. Sarstedt et al. (2017) described the range of between 0.00 and 0.15, more than 0.15 and 0.35, and above 0.35 as minor, medium, and substantial effect sizes, respectively. The effect sizes of the influence of LSCA (0.128) and SCCR (0.145) on CA were both small. Meanwhile, Fornell and Cha (1994) noted the predictive relevance of a model with Q^2 of above zero (Henseler et al., 2015). The recorded Q^2 of 0.290 and 0.321 for CA and SCCR, respectively, confirmed the predictive relevance of the model. Collectively, these tests confirm the statistical, predictive, and practical robustness of the model.

5. Discussion

Focusing on Iraqi food and beverage SMEs, this study assessed the direct influence of LSCA on CA, the mediating effect of SCCR on the relationship between LSCA and CA, and the moderating effect of IT capabilities on the relationship between LSCA and SCCR. The obtained results (Table 7) confirmed these relationships. These results were in line with the RBV theory (Wernerfelt, 1984), underscoring the importance of internal organisational resources, including IT capabilities, and activities for organisations to gain CA. The findings also supported the TCE theory (Williamson, 1979, 1985), highlighting SCCR as a significant mechanism in enhancing competitive advantage. The results demonstrated how competitive advantage can be obtained and sustained through SCCR and managing internal activities and capabilities. In other words, SMEs must consider SCCR strategies and IT capabilities to enhance their competitive advantage.

Furthermore, although some prior studies supported these outcomes (e.g., Nimeh et al., 2018; Tariq et al., 2023), other studies (e.g., Kusmantini et al., 2018; Khalfallah and Lakhal, 2020) demonstrated otherwise. This means that lean practices do not always translate into performance gains, particularly when institutional and technological readiness is low. In contrast, our study shows that even in a resource-constrained environment like SMEs in Iraq, lean supply chain activities and IT capabilities can function as strategic enablers when adapted with context-specific factors, thus reinforcing the RBV emphasis on resource value and the TCE focus on transaction efficiency. This strengthens the argument for localized strategies and capability adaptation in SME-driven economies.

This study uniquely expanded the current literature on the synergistic connection between LSCA and CA within the Iraqi context of food and beverage SMEs. Cost efficiency and strategic advantages were incorporated in the proposed research model, which involved the mediating role of SCCR in the relationship between LSCA and CA. This study's results on the positive relationship between SCCR and CA further enriched the current understanding of the underlying mechanisms. Addressing the lack of studies on the interrelationships between the antecedents and effects of SCCR (Selvaraju et al., 2017; Wang et al., 2020; Nguema et al., 2022), this study empirically proved the significance of SCCR mechanisms in enhancing CA. This study underscored the need for Iraqi food and beverage SME owners and managers to make proactive efforts of reducing supply chain costs for higher competitive positioning.

Another novel contribution of this study involved the empirical evidence on the moderating role of IT capabilities. There have been limited studies on IT as a moderator in the relationship between LSCA and performance outcomes, such as SCCR (Garcia-Buendia et al., 2021; Oliveira et al., 2022; Khawka et al., 2024). The obtained results implied higher operational efficiency and performance for SMEs with the support of IT. The promotion of seamless communication and collaboration between supply chain partners through IT effectively yields clearer understanding of cost-saving opportunities and efficiency improvements, strengthens their commitment to LSCA, and ensures the responsiveness and transparency of the processes involved. Addressing the gap in literature on the moderating role of IT, this study provided a more nuanced understanding of its influence on the relationship between LSCA and SCCR. More broadly, these findings align with the conceptual work by Abdeldayem and Aldulaimi (2023), who argue that Islamic crowdfunding (ICF) serves as a strategic capability tailored to the institutional environment of Middle Eastern SMEs. Like ICF, LSCA and IT capabilities function as context-specific enablers of competitive advantage, underscoring the importance of developing capabilities that are aligned with both operational needs and local institutional conditions.

Table 5
Exploratory factor analysis: Factor loadings for explanatory variables.

Lean Supply Chain Activities									Supply Chain Cost Reduction						
Items	1 LC	2 LM	3 LP	4 LS	5 LT	6 LW	Initial	Extraction	Items	1 PC	2 IC	3 MC	4 TC	Initial	Extraction
LC1	.814						1.000	.675	PC1	.840				1.000	.781
LC2	.799						1.000	.641	PC2	.763				1.000	.733
LC3	.793						1.000	.660	PC3	.512				1.000	.473
LC4	.752						1.000	.519	PC4	.469				1.000	.401
LC5	.716						1.000	.610	PC6	.847				1.000	.778
LC7	.542						1.000	.570	IC3		.783			1.000	.699
LC8	.633						1.000	.662	IC4		.789			1.000	.708
LM1		.738					1.000	.732	IC5		.720			1.000	.621
LM3		.708					1.000	.560	IC6		.708			1.000	.587
LM5		.701					1.000	.560	MC2			.667		1.000	.551
LM6		.564					1.000	.554	MC3			.555		1.000	.458
LM7		.696					1.000	.614	MC4			.441		1.000	.459
LM8		.711					1.000	.626	MC5			.519		1.000	.570
LP1			.682				1.000	.803	MC6			.699		1.000	.607
LP2			.674				1.000	.802	TC1				.798	1.000	.695
LP4			.630				1.000	.715	TC2				.859	1.000	.774
LP5			.600				1.000	.659	TC3				.806	1.000	.710
LP6			.643				1.000	.733	TC4				.806	1.000	.680
LP7			.622				1.000	.635	TC5				.703	1.000	.512
LP8			.562				1.000	.724	TC6				.833	1.000	.739
LS1				.755			1.000	.725							
LS2				.747			1.000	.731							
LS3				.730			1.000	.615							
LS4				.675			1.000	.632							
LS5				.649			1.000	.578							
LS6				.522			1.000	.500							
LS8				.621			1.000	.511							
LT1					.742		1.000	.668							
LT2					.741		1.000	.723							
LT3					.734		1.000	.730							
LT4					.698		1.000	.710							
LT5					.597		1.000	.627							
LT6					.689		1.000	.624							
LT7					.601		1.000	.583							
LT8					.589		1.000	.722							
LW1						.799	1.000	.646							
LW2						.754	1.000	.677							
LW3						.533	1.000	.683							
LW4						.708	1.000	.555							
LW5						.664	1.000	.596							
LW6						.598	1.000	.702							
LW7						.712	1.000	.652							
LW8						.555	1.000	.616							

Abbreviations: LP denotes lean purchasing; LS denotes lean supplier; LT denotes lean transportation; LM denotes lean manufacturing; LW denotes lean warehousing; LC denotes lean customer; PC denotes purchasing cost; IC denotes inventory cost; MC denotes manufacturing cost; TC denotes transportation cost.

Table 6
KMO and Bartlett's test.

Lean Supply Chain Activities	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.866
	Bartlett's Test of Sphericity	8517.986
		499
		0.000
Supply Chain Cost Reduction	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.843
	Bartlett's Test of Sphericity	3753.806
		190
		0.000

The theoretical integration of RBV and TCE is further substantiated by these results. While RBV highlights the importance of resource uniqueness and capability leverage—represented by IT and lean integration—TCE underscores the critical role of cost efficiency in driving competitiveness. This study bridges these perspectives by empirically showing that LSCA (as internal capabilities) reduce transaction costs (SCCR), which in turn enhances CA. IT capabilities, as digital resources, further enable this chain of value creation. Hence, this study provides a cohesive theoretical framework where strategic resource deployment and cost-efficiency logic converge.

Table 7
Results of structural model assessment.

Relationships		Std. Beta	Std. Error	t-value	p-value	BCI LL	BCI UL	f^2	VIF	Results
H1	LSCA → CA	0.348	0.057	6.116	0.000	0.093	0.377	0.128	1.225	Supported
H2	LSCA → SCCR	0.198	0.075	2.645	0.008	0.111	0.428	0.225	2.051	Supported
H3	SCCR → CA	0.207	0.049	4.191	0.000	0.016	0.372	0.145	1.225	Supported
H4	LSCA → SCCR → CA	0.041	0.018	2.282	0.023	0.215	0.325			Supported
H5	IT × LSCA → SCCR	0.124	0.058	2.132	0.033	0.295	0.527			Supported

5.1. Theoretical implications

This study contributes to theory by empirically integrating the Resource-Based View (RBV) and Transaction Cost Economics (TCE) to explain how lean supply chain activities (LSCA) drive competitive advantage (CA) through supply chain cost reduction (SCCR), particularly in SMEs. While RBV highlights LSCA and IT capabilities as firm-specific strategic resources, TCE emphasizes transaction efficiency as a source of CA. This study enriched the existing literature in multiple ways. Firstly, the development of a comprehensive measurement scale for LSCA in this study provided new knowledge and enhanced the overall understanding of how these activities influence CA. Secondly, the development of a new measurement scale for SCCR in this study enhanced the overall understanding of the costs incurred within and beyond the organisational processes, facilitating the assessment of the total supply chain costs more effectively. Most prior studies focused on mathematical approaches, conceptual frameworks, and case studies related to cost issues within the supply chain. Consequently, the interrelationships between the antecedents and effects of SCCR have remained underexplored (Selvaraju et al., 2017; Wang et al., 2020; Nguema et al., 2022). Thirdly, this study introduced an integrative research model that incorporated mediating (SCCR) and moderating (IT) variables, offering in-depth insights on the relationship between LSCA on CA (Kankam and Dza, 2023). Addressing the gaps in literature, especially on the moderating role of IT, this study demonstrated the interactions of LSCA, SCCR, IT, and CA. The derived theoretical implications expanded the current literature on how IT can mitigate the outcomes of other factors on the relationship between LSCA and CA. Finally, most prior studies on LSCM focused on the manufacturing industry in developed countries, and these studies overlooked those in developing countries, especially SMEs (Kosasih et al., 2023a; Bashar et al., 2024). This study contributed valuable insights on LSCA within the context of the MENA region.

5.2. Managerial implications

This study's findings on the interactions of LSCA, SCCR, IT, and CA presented significant managerial implications. Firstly, this study demonstrated that SMEs, especially in developing countries, can benefit from LSCA for enhanced CA. This study also empirically proved SCCR as a key mechanism to enhance the influence of LSCA on CA. Strategic reduction of supply chain costs can help SME owners and managers to achieve organisational success and better competitiveness in this increasingly intense market competition. Furthermore, this study underscored the moderating role of IT in enhancing the positive influence of LSCA on SCCR and subsequently, CA. Therefore, SMEs must invest in IT capabilities to optimise and enhance the overall operation and supply chain performance, CA, and collaboration with supply chain partners. Through strategic utilisation of IT, communication and data sharing across the entire supply chain network are more seamless.

While lean supply chain activities offer significant cost and competitive benefits, their implementation in Iraqi SMEs is often met with internal and external resistance. Internally, employees—particularly in manufacturing roles—may perceive lean practices and automation as threats to job security, fueling resistance to process changes. Externally, many suppliers remain entrenched in traditional, relationship-based transactions and may be hesitant to adopt data-driven collaborations central to lean integration. These challenges are further compounded by infrastructure limitations, such as erratic power supply disrupting lean warehousing operations, and cultural preferences for centralized decision-making, which conflict with lean's emphasis on empowered teams and decentralized control. To overcome these hurdles, managers should consider a phased approach—for example, piloting lean purchasing initiatives with trusted suppliers—and simultaneously advocate for broader structural support through public-private partnerships aimed at addressing systemic constraints.

The results provide valuable practical insights for food and beverage SMEs operating in highly resource-constrained environments. The path coefficient between LSCA and CA ($\beta = 0.348$, $f^2 = 0.128$), as shown in Table 7, suggests that implementing lean supply chain activities has a meaningful direct impact on enhancing competitive advantage. Notwithstanding that the effect size is considered small to moderate, it holds particular significance in the context of Iraqi food and beverage SMEs, where SMEs face supply chain disruptions, limited access to capital, and infrastructural weaknesses, where even incremental improvements in operational efficiency and service quality can contribute to stronger performance outcomes. The effect of LSCA on SCCR ($\beta = 0.198$, $f^2 = 0.025$) and SCCR on CA ($\beta = 0.207$, $f^2 = 0.045$) confirms that supply chain cost reduction serves as a practical mechanism through which lean supply chain activities translate into competitive advantage. These findings highlight the importance of adopting cost-reduction-focused strategies, particularly for SMEs operating in resource-constrained environments. In addition, the moderating effect of IT capabilities on the relationship between LSCA and SCCR ($\beta = 0.124$) demonstrates that IT capabilities can significantly strengthen the impact of lean supply chain activities on cost reduction. This is particularly important for Iraqi SMEs, where IT infrastructure and digital integration remain underdeveloped. Even a modest improvement in IT capabilities can enhance visibility, reduce errors, and improve coordination across the supply chain. These findings suggest that lean supply chain activities, supported by targeted IT investments, offer a feasible and impactful strategy for enhancing SME competitive advantage in Iraq.

6. Conclusion

With respect to the RBV and TCE theories, the interrelationships of LSCA, SCCR, IT, and CA were empirically assessed in this study. The obtained results demonstrated the significance of SCCR as mediator in the relationship between LSCA and CA and IT capabilities as moderator in the relationship between LSCA and SCCR. This study clearly demonstrated the benefits of leveraging LSCA for favourable outcomes in terms of SCCR and CA and the significant need to commit to the adoption of LSCA for enhanced CA. This study has presented valuable insights on the significance of IT capabilities in moderating the influence of LSCA on SCCR. Overall, this study expanded the overall understanding on the complex dynamics of LSCA, SCCR, and IT capabilities within a critically underexplored context. Enhancing CA requires the adoption of lean activities as the key mechanisms of the supply chain for organisations, especially SMEs, to achieve better cost efficiency and performance. Additionally, leveraging IT capabilities can amplify the benefits of these lean activities and strategically enhance cost reduction and higher competitiveness in the marketplace.

7. Limitations and direction for future research

This study encountered several limitations. Firstly, this study addressed the potential issue of common method bias through procedural and statistical controls. However, the use of a cross-sectional design and self-reported questionnaire data may introduce bias and restrict the ability to draw causal inferences. Future research is encouraged to adopt a longitudinal design, collecting data at multiple points in time to better capture changes over time and control for stable individual differences. Secondly, this study employed perceptual measures of IT capabilities, based on respondents' subjective evaluations rather than objective system-level data. Although this approach is common in behavioral research, it may be affected by respondent bias or misinterpretation. Future research may benefit from incorporating objective IT usage data or triangulating perceptual responses with system audits or digital adoption metrics. Thirdly, the study focused specifically on the food and beverage sector in Iraqi SMEs, which limits the generalizability of findings across other industries or countries. Future research could explore the same model across different SME sectors or

regional contexts, such as other MENA countries, to validate and extend the findings. Additionally, while this study provides extensive empirical evidence through quantitative analysis, future research could employ a mixed-methods approach to gain deeper contextual insights. Finally, the role of digitalisation in SME competitiveness deserves further exploration. Future studies could investigate how advanced technologies—such as the Internet of Things (IoT), digital twins, artificial intelligence (AI), big data analytics, automation, and blockchain may transform supply chain operations, enhancing responsiveness, efficiency, and adaptability to market fluctuations, thereby influencing supply chain performance and competitive advantage in SMEs.

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Ethical statement

Not applicable because this study does not include any research on animal and human subjects under the Bioethics Act.

CRediT authorship contribution statement

Siti Azfanizam Binti Ahmed: Writing – review & editing, Supervision. **Rami Hikmat Fouad Al-Hadeethi:** Writing – review & editing, Supervision. **Zeyad Mustafa Hamed Khawka:** Writing – review & editing, Writing – original draft, Software, Resources, Methodology, Funding acquisition, Data curation, Conceptualization. **Azmawani Abd Rahman:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Shafie Bin Sidek:** Writing – review & editing, Supervision, Project administration, Methodology.

Declaration of Competing Interest

All the authors of this paper declare the existence of no mutual conflict of interest.

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Informed Consent

Informed consent was obtained from all individual participants of the study.

Appendix A. : Construct measures and their sources

Constructs/Sub-Constructs	Measurement Items	Sources
Lean supply chain activities (LSCA)		Bhasin and Burcher (2006), Wilson and Roy (2009), Hagström and Wollner (2011), Yu et al. (2012), Oko (2016), Suresh and Nathan (2020), and Taghipour et al. (2020) using a newly developed measurement.
Lean purchasing (LP)	LP1: Our company's lean purchasing is characterised by flexibility and meets all kinds of demands. LP2: Our company's lean purchasing activity provides materials identical to customers' requirements. LP3: Our company meets its material needs through electronic purchases. LP4: Our company's lean purchasing practices reduce purchasing costs. LP5: Our company works with a limited number of key suppliers to enhance efficiency and maintain strong relationships. LP6: Our procurement committees are experienced and efficient. LP7: Our purchasing committees are keen to transfer necessary information to suppliers on an ongoing basis. LP8: Overall, our company aims to eliminate all kinds of waste in purchasing activities.	
Lean supplier (LS)	LS1: Our company selects suitable suppliers from our well-monitored supplier database. LS2: Our company relies on specific criteria for selecting suppliers. LS3: Our suppliers are keen to provide the company's needs in line with customers' requirements. LS4: Our suppliers can adapt to changes in their adoption of the lean concept. LS5: Our suppliers' procedures contribute to improving logistical activities. LS6: Our company is committed to fostering relationships with suppliers that are built on shared values and long-term goals. LS7: Our company's suppliers are characterized by trustworthiness and reliability. LS8: Overall, our company works towards eliminating waste in supplier relationships.	Barla (2003), Wu (2003), Simpson and Power (2005), Othman and Ghani (2008), Oko (2016), Belkadi et al. (2018), Kumar et al. (2019), Abdillah and Chang (2022), Garcia-Buendia et al. (2023), Huang et al. (2023), and Changalima et al. (2024) using a newly developed measurement.
Lean transportation (LT)	LT1: In our company, transportation activity is considered as an added value activity.	Taylor and Martichenko (2006), Villarreal et al. (2009), Wei (2010), Villarreal. (2012), Arriaga et al. (2013), Villarreal et al., (2016), Oko (2016),

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Constructs/Sub-Constructs	Measurement Items	Sources
	LT2: The company has a smooth flow of goods and services to customers. LT3: Our company uses appropriate means of transportation that suit the nature of its market. LT4: Our company uses documented and accurate information to manage transportation processes effectively. LT5: Our company ensures timely supply to reduce mileage, time, and costs. LT6: Our company has the right and efficient human resources to manage transportation activity. LT7: Our company's reduction in transportation costs contributes to strengthening its competitive position. LT8: Overall, our company is working to reduce waste in transportation operations.	Sternberg and Harispuru (2017), Villarreal et al. (2018), and Sterner et al. (2024) using a newly developed measurement.
Lean manufacturing (LM)	LM1: Our company's manufacturing processes aim at fulfilling customers' requirements. LM2: Our company's manufacturing systems increase the staff productivity. LM3: Our company's manufacturing processes contribute to compatibility between customers' requirements and the possibilities of suppliers. LM4: Our company aligns production levels with actual demand to reduce overproduction and waste. LM5: Partnership with suppliers helps to avoid interruption of production processes in our company. LM6: Our company's manufacturing processes rely on real-time data and demand forecasting systems to minimize inaccuracies in demand predictions. LM7: Our company's manufacturing processes are characterised by its ability to produce products at reduced costs. LM8: Overall, our company works towards eliminating waste in manufacturing operations.	Womack and Jones (1997), Shah and Ward (2003), Melton (2005), Bhasin and Burcher (2006), Jabbour et al. (2013), Kimani (2013), Kumar et al., (2018), Vanichchinchai (2019), Hoque et al. (2020), Budianto et al. (2021), Logesh and Balaji (2021), Tripathi et al. (2022), Garcia-Buendia et al. (2023), and Ionel (2024) using a newly developed measurement.
Lean warehousing (LW)	LW1: Our company follows warehouse procedures that facilitate logistical activities, such as receiving, picking, packing, shipping, and returns processing. LW2: Our company has an inventory information system that contributes to avoiding the occurrence of inventory mistakes. LW3: Our company's warehousing procedures facilitate the work of suppliers. LW4: Our company directs warehousing operations toward serving customers. LW5: The warehouse workers in our company have the required experience. LW6: Withdrawal from the company's warehouses is made in case of real order through the adoption of pull principle. LW7: Our company continuously provides information on the stock levels to the concerned sections. LW8: Overall, our company works towards reducing waste in warehousing operations.	Tostar and Karlsson (2008), Daud (2010), Bozer (2012), De Visser (2014), Swart (2015), Sharma and Shah (2015), Dotoli et al. (2015), Abushaikha et al. (2018), Abideen and Mohamad (2019), Martins et al. (2020), Peralta et al. (2020), Tiupysheva et al. (2023), Odeyinka and Omoegun (2023), Garavito-Bejarano et al. (2023), Manik (2023), and Efendi and Aryanny (2024) using a newly developed measurement.
Lean customer (LC)	LC1: Our company communicates with customers to define their needs accurately. LC2: Our company works to determine the value from the customers' point of view to avoid superfluous costs, such as overproduction, excess inventory, or unnecessary processes. LC3: Our company uses the continuous improvement principle to reduce costs afforded by customers. LC4: Our company achieves cooperation and partnership with customers by fulfilling their requirements. LC5: Our company has accurate information about its customers. LC6: Our company has skilled workers who can communicate with customers to specify their exact requirements. LC7: Novel ideas provided by customers contribute to compatibility between the products offered by the company and customers' needs. LC8: Overall, our company aims to eliminate all kinds of waste in customer interactions.	Piercy and Rich (2009), Komssi et al. (2015), Oko (2016), Koval et al. (2018), Pater et al. (2019), Liczmańska-Kopcewicz, (2020), van Assen (2021), Shbita et al. (2023), Kurucz & Buics (2024), and Fatorachian et al. (2025) using a newly developed measurement.
Supply chain cost reduction (SCCR)		
Purchasing cost (PC)	PC1: Our company reduces procurement costs because we buy raw materials according to the production requirements. PC2: Our company has good control on purchasing cost. PC3: Our suppliers offer competitive prices, which minimise purchasing costs. PC4: Our suppliers provide high-quality goods to ensure waste reduction.	Pettersson and Segerstedt (2013), Pettersson & Segerstedt (2015), Ramos et al. (2021), Maharani et al. (2022), Ferreira and Silva (2022), and Changalima et al. (2024) using a newly developed measurement.

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Constructs/Sub-Constructs	Measurement Items	Sources
	PC5: Our company's purchasing activity reduces procurement transaction cost. PC6: Overall, our purchasing cost is lower.	
Inventory cost (IC)	IC1: Our company reduces capital cost in inventory, which propels our growth. IC2: Our company has a supply chain working to reduce inventory holding costs (tax, insurance, and shrinkage). IC3: Our company has a supply chain working to reduce storage costs. IC4: Our company has a supply chain that reduces inventory carrying costs. IC5: Our company minimises inventory levels and maintains the right amount of stock across our supply chain. IC6: Overall, our inventory cost is lower.	Pettersson and Segerstedt (2013), Pettersson (2015), and Nimeh et al. (2018), Govindasamy et al. (2022), Hemant and Shafighi, (2023), Parfenova (2023), Zheng & Chen, (2024), and Janzen et al. (2024) using a newly developed measurement.
Manufacturing cost (MC)	MC1: Our company's practices reduce the manufacturing lead time. MC2: Our company's practices reduce the direct and indirect labour costs. MC3: Our company's practices improve product quality, reduces defects, and rework costs. MC4: Our company's production reduces equipment inefficiency and downtime. MC5: Our company's production reduces the material costs. MC6: Overall, our manufacturing cost is lower.	Chiadamrong and Wajcharapornjinda (2012),Pettersson and Segerstedt (2013), Pettersson (2015), El-Khalil (2022), Khanna et al. (2024), Pirskanen (2024), and Sutthibutr et al. (2024) using a newly developed measurement.
Transportation cost (TC)	TC1: Our company has transportation activity in terms of delivery time; thus, it reduces transportation costs. TC2: Our company has transportation activity in terms of flexibility; thus, it reduces transportation costs. TC3: Our company's transportation activity ensures waste reduction. TC4: Our company's transportation activity reduces inbound and outbound transportation costs. TC5: Our company packs more products into each load, thereby improving capacity utilisation to reduce transportation costs. TC6: Overall, our transportation cost is lower.	Pettersson and Segerstedt (2013), Pettersson (2015), Ehsanifar et al. (2021), Maas (2021), Alshurideh et al. (2022), Damodaram et al. (2022), Mogoi & Osoro (2022), Wei et al. (2023), Kidd et al. (2024), Ghomi et al. (2024), Ekai & Kamaara (2024), Pajić et al. (2024), and Bäckström (2024) using a newly developed measurement.
Information technology capabilities (ITC)		
IT talent capabilities (ITTC)	ITTC1: Our company's IT-related employees can skilfully use IT or its system. ITTC2: Our company's IT-related employees are highly motivated and proactive in their work. ITTC3: Our company's IT-related employees are good at self-study. ITTC4: Overall, our company's IT talent capabilities improve supply chain performance.	Lu and Ramamurthy (2011), Zeng and Lu (2021) and Kyagante et al. (2024) with some modifications.
IT infrastructure capabilities (ITIC)	ITIC1: Our company has an accurate hardware and software platform. ITIC2: Our company has information systems or IT systems that are highly compatible and scalable. ITIC3: Our company has a unified information system to manage supply, sales, and other information. ITIC4: Overall, our company's IT infrastructure capabilities improve supply chain performance.	
IT internal communication capabilities (ITCC)	ITCC1: Each department fully exchanges orders, production, sales, and other information in our company. ITCC2: All departments cooperate fully in our company. ITCC3: Internal staff can communicate well in our company. ITCC4: Overall, IT internal communication capabilities improve our company's supply chain performance.	
IT external communication capabilities (ITCE)	ITCE1: Our company fully communicates with key partners. ITCE2: Our company has a complete IT system for partner management. ITCE3: Our company makes full use of IT and its system to communicate and cooperate with key partners (e.g., using networks, e-commerce, and other technologies). ITCE4: Overall, our company's IT external communication capabilities improve supply chain performance.	
Competitive advantage (CA)		Li et al. (2006) with some modifications.
Price/cost (PCO)	P/C1: Our company offers competitive prices. P/C2: Our company uses its available resources economically to reduce costs. P/C3: Our company uses its available resources rationally to reduce costs. P/C4: Overall, our company performs better than the competitors in terms of cost advantage.	
Quality (QUL)	QUL1: Our company can compete based on quality. QUL2: Our company offers highly reliable products. QUL3: Our company offers very durable products. QUL4: Our company offers high-quality products to our customers.	

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Constructs/Sub-Constructs	Measurement Items	Sources
	QUL5: Overall, our company performs better than the competitors in terms of quality advantage.	
Delivery dependability (DD)	DD1: Our company delivers the kind of products needed.	
	DD2: Our company delivers customer order on time.	
	DD3: Our company provides dependable delivery.	
	DD4: Overall, our company performs better than the competitors in terms of delivery advantage.	
Product innovation (PI)	PI1: Our company provides customised products.	
	PI2: Our company provides product altering to meet customers' needs.	
	PI3: Our company responds well to customers' demand for "new" features.	
	PI4: Overall, our company performs better than the competitors in terms of innovation advantage.	
Time to market (TMM)	TM1: Our company delivers new products to market quickly.	
	TM2: Our company is first in the market to introduce new products.	
	TM3: Our company has lower time-to-market than the industry's average.	
	TM4: Overall, our company performs better than the competitors in terms of time advantage.	

Data availability

The data of the paper, which support the analysis and results of this paper, are available with the corresponding author, and the data can be obtained from the authors upon request.

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