Uncertain Supply Chain Management 13 (2025) 121–136

Contents lists available at GrowingScience

Uncertain Supply Chain Management

homepage: www.GrowingScience.com/uscm

Examining the mediating role of ambidexterity, wireless IT competence, and sensing capability of supply chain management to drive innovation capability in higher education

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A B S T R A C T

Article history:
Received May 15, 2024
Received in revised format May 23, 2024
Accepted July 15 2024
Available online
July 15 2024

Keywords:
Sensing capability of supply chain management
Transactional and transformational leadership
Wireless IT competence
Ambidexterity and innovation capability

This study examines the interaction effect between transformational leadership, transactional leadership, wireless IT competence, ambidexterity and supply chain management capability in increasing innovation capability. By using a knowledge-based view and dynamic capability theory basis, this research has provided an exploration of the supply chain of a merchant marine college and its impact on innovation capability using a quantitative method approach. The authors collected data from a cross-section of 673 questionnaires distributed to Managers in 3 managerial classifications from top, middle and bottom in the technical service unit of the merchant marine college under the Indonesian Ministry of Transportation. A total of 523 data were collected from questionnaires that could be continued for data analysis. The results of this study indicate that all the hypotheses put forward in this study are accepted, and the role of mediating variables in this research has succeeded in demonstrating their role in mediating each antecedent variable to increase innovation capability. The theoretical implication of this research is the growth of cloud or virtual supply chains facilitated by digital wireless communications, and internet technology is advancing logistics and supply chain innovations. Also, it can reinforce theory and dynamic capability.

1. Introduction

Current technological advances, as seen in cloud computing, digital communications, cellular technology, especially in smartphones, artificial intelligence, and logistically facilitated machine learning, have been able to provide significant access to reduced market distances and the emergence of market demand adjustments to a relatively real-time response when using remote and wireless digital technologies (Pang et al., 2021). Leadership can be considered a predictor that significantly influences innovative capabilities and sustainable innovation (Mumford & Licuanan, 2004). Various leadership concepts, including transformational leadership, have provided technology adoption in creating new leadership and the emergence of radical innovations in digital transformation (Jones et al., 2021). Transformational leaders are expected to have a focus on developing new solutions and be able to encourage employees to rethink their assumptions (Christensen et al., 2003). Transformational leadership can be considered a sufficiently inspiring trait to stimulate intellectually and provide individual attention, as well as the emergence of charismatic traits (Bass, 2000; Vera & Crossan, 2004).

Ambidexterity leadership theory has provided evidence that when a leader is involved in a form of leadership, the leader can create exploitation and exploration within an organization. It will bring up a paradox where employees can exploit a relatively high level of efficiency by following standards that simultaneously will explore creativity without flexible leadership (Hunter & Cushenbery, 2011; Rosing et al., 2011). In the context of leadership, ambidexterity is classified into two groups, namely

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ISSN 2291-6830 (Online) - ISSN 2291-6822 (Print)

doi: 10.5267/j.uscm.2024.7.009

transactional leadership and transformational leadership (Chandrasekaran & Linderman, 2015). Ambidexterity leadership can be considered as the ability of a leader who is holistically able to encourage his followers to provide long-term innovation stimuli and can pursue short-term performance through the use of different enterprise systems (Muller & Peres, 2019; Pambudi et al., 2022). When a leader can lead ambitiously, the manager will be able to encourage his followers to become drivers who can encourage workers to try adaptively, which will direct workers or subordinates to use enterprise systems optimally and freely, according to their needs in realizing their performance or innovation (Jiao et al., 2015; Pambudi Widiatmaka et al., 2023).

Transactional leadership requires companies to promote various uses of the exploitation of employees. It is intended for companies to maintain the status quo. Of these, a form of thought emerges that is quite crucial and interesting to study, related to how to use a form of enterprise system that is quite exploratory and exploitative to promote employees so that it stimulates a form of learning to develop wireless IT competencies. Many information technologies provide a form of description regarding the capability to change and strategies for companies in implementing supply chains that are expected to be demand-driven through supply chains that are quite real-time, instant and fast (Musril et al., 2023; Teubner & Stockhinger, 2020). It can be easily demonstrated through the capabilities of smartphone technology, which allows communication anytime and anywhere (Bang & Luft, 2013; Biocca et al., 2007). In supply chain management, digital cellular communication shows the organization's ability to monitor, integrate and coordinate various supply chain activities in remote locations far from the organization's distribution center or head office.

Conceptually, organizational ambidexterity can be thought of as an ability to support innovative capabilities by providing assistance to companies and avoiding the nature of search that depends on exploratory learning paths or the emergence of various sets of exploitative learning competencies (Ahuja & Morris Lampert, 2001; Tang et al., 2021). The innovative capabilities resulting from transformational and transactional leadership depend on various things, including acquiring, using, and disseminating new knowledge in supply chain integration (Damanpour, 1991; Moorman & Miner, 1998). When an organization's supply chain consists of various activities related to the flow of important information, it is a special integration of knowledge and the transformation and transactional of goods from the register of raw materials to the end user. These processes will be interdependent and require learning to access and apply relevant external knowledge (Handfield & Nichols Jr, 1999). Thus, it is necessary to have competence in the use of IT that can lead companies to the creation of ambidexterity and the emergence of facilitation from the combination of exploration and exploitation.

Communication and information technology use in supply chain integration has been explicitly recognized as contributing to increasing organizational innovation (Halldórsson et al., 2015). It can be realized widely in supply chain practices. When the supply chain is integrated, and the process has the means to form a sufficiently efficient flow of information in supply and demand networks, knowledge integration can be enhanced by applying technology. Several previous studies have empirically proven the importance of supply chain integration and knowledge in improving supply chain performance. Innovation in the supply chain can take the form of boundaries that provide a form of separation between digital networks and cloud integration of IT capabilities and systems that have been scattered so far (Eng et al., 2023; Galliers & Swan, 1999). The organization's innovative capabilities can be seen as the result of various integrations of knowledge that are rooted in various theories that have been quite well established so far, such as Knowledge-Based View theory and Dynamic Capability theory, which can be considered as a reflection of dynamic knowledge-based capabilities (Teece et al., 1997).

Innovative capabilities can be articulated as an ability to benefit existing technologies or create new ones through tools expected to provide an existential form of innovation strategy support in improving organisational performance (Burgelman et al., 1996; Dian et al., 2022). Economic development theory has demonstrated the existence of competition based on innovation and the destruction of existing creativity to drive business progress. This theory has derived a dynamic capabilities framework in the literature (Teece et al., 1997; Teece & Pisano, 2003). Thus, this dynamic term will refer to an environment capable of changing rapidly enough. The term capability emphasises the role of strategic management. Meanwhile, functional competence against environmental changes is also considered a dominant factor in determining the success of the management process. A supply chain is recognized as a first step that can provide overall dynamic capabilities in the supply chain (Aslam et al., 2018; Kundori & Sukrisno, 2023)(Aslam et al., 2018), and the quality of dynamic learning and integration and coordination depends on the severity of the supply chain level when in a turbulent and competitive environment, very competitive.

Supply chain in the context of supply chain management is very dependent on various aspects related to how well companies can provide information integration with their supply partners. Various scientific studies have provided conceptual conclusions about diversifying the potential strategic meanings of supply chain and management through environmental sensing. Innovation capability is often associated with organization ambidexterity because the capacity possessed by an organization to exploit internal resources and explore external opportunities will be considered as a capability that can provide a style for the implementation of corporate strategy (Kang & Kang, 2009; Raisch & Birkinshaw, 2008; Tang et al., 2021). An organization is expected to increase various innovative capabilities by exploiting and exploring the use of new technologies that are owned comprehensively. In addition, they can also promote ambidexterity to improve the competitiveness of their supply chain (Jansen et al., 2012; Kang & Snell, 2009). It holistically can increase innovation capability.

This study departs from two main theories: Knowledge-Based View and Dynamic Ability theory (Felin & Hesterly, 2007). The theory assumes that companies can provide various tests related to IT competencies and transactional and transformational leadership to influence innovation capabilities and networks owned by an organization. Wireless IT competence can be considered a dimension with sufficient composite attributes oriented towards value creation and sustainability. When organizations are in modern networks, supply chain innovation will require human resource leadership to create an environment that encourages individual knowledge to be used collectively to benefit the organization (Eng et al., 2023; Mabey & Zhao, 2017). Regarding sensing capability, the supply chain context is important and can influence leaders and various integrations of knowledge and IT capabilities (Scarbrough, 2000; Syed et al., 2020).

Knowledge-based views and dynamic capability have provided strong articulations regarding leadership and ambidexterity, which can be considered a source that enhances IT competence. Furthermore, this wireless IT competence is expected to be a form of leverage for sensing capability supply chain management. Thus, this study seeks to fill the gap between leadership and transactional leadership transformation to increase innovation capability by mediating competency, ambidexterity and sensing capability in supply chain management to improve innovation capability at merchant marine college colleges in Indonesia.

2. Literature review and model development

2.1 Knowledge-based view

Understanding the Knowledge-Based View theory and a view of dynamic capabilities in organizations can provide critical theoretical insight into the importance of knowledge and resources, which are considered This theory largely provides an extension of the Resource-Based View theory, which is rooted in the identification of both tangible and intangible knowledge and resources as the basis for capability development and includes a renewal side that can be emphasized in organizational capabilities (Teece et al., 1997; Widiatmaka et al., 2023). This means that knowledge is the primary resource that will underlie the creation of new value, the emergence of heterogeneity, and competitive advantage (Grant, 1996; Kogut & Zander, 1992).

Dynamic capability refers to providing integration in building and configuring various competencies in response to changes in the business environment (D. Teece & Pisano, 2003). In line with the capability perspective, the Knowledge-Based View can provide an overview of the importance of organizational knowledge and learning, where a supply chain responsibility towards the surrounding environment will be able to reflect a dynamic process in learning and updating capabilities. Thus, knowledge-based and dynamic capabilities complement specific knowledge integration behaviors and organizational mechanisms by applying new technologies to enhance innovation.

Sources of innovation that come from capabilities can be generated and formed through leadership and collective knowledge from members. In the supply chain, it can affect the competence and ability of organisation members to change and update old routines to realize a fairly competitive market implementation (Nemanich & Vera, 2009). Leadership can bring out an organization's supply chain capabilities and innovative capabilities. The application of various technological strategies and interactions is quite complex, and various resources are owned by the organization or members in the organization's internal and external supply chains (Frohlich & Westbrook, 2001; Scarbrough, 2000; Syed et al., 2020).

Senior managers ' transformational and transactional leadership behaviors are proven to produce effective and relevant leadership in a dynamic environment (Waldman et al., 2001). This behavior can also lead to the emergence of exploitative and exploratory ambidexterity (Vera & Crossan, 2004). This concept relates to various challenges to a status quo in the learning process. It is also in line with the development of quite innovative abilities. In line with these assumptions, an information technology competency will enable organizations to generate business value through various developments of organizational capabilities that are quite innovative (Benitez et al., 2018; Mikalef & Pateli, 2017; Schryen, 2013).

2.2 Transformational Leadership, Transactional Leadership and Competence in the Use of Wireless IT

Various previous studies indicate that two types of leadership have fundamentally contributed to showing the level of ambidextrous, namely transformational leadership and transactional leadership (Chandrasekaran & Linderman, 2015). Transactional leadership is closely related to exchanging equal value, keeping track of, and avoiding risk (Zhang & Guo, 2019). It can provide emphasis regarding the timely completion of the required work and planned goals so that transactional leaders can ask employees to use existing resources in the organization efficiently and pressure those who do not implement them (Eng et al., 2023; Pieterse et al., 2010; Eng et al., 2023; Pieterse et al., 2010). Transactional leaders can contribute to the emergence of intentions that provide timely and constructive feedback to enable employees to operate well (Chandrasekaran & Linderman, 2015; Eng et al., 2023; Chandrasekaran & Linderman, 2015; Eng et al., 2023).

Meanwhile, transformational leadership will be able to provide motivation to stimulate individual considerations and the influence they generate (Cho et al., 2011; Cho et al., 2011). Their problems with various methods are neoteric (Li & Hsieh, 2007; Li & Hsieh, 2007). Transformational leadership will require leaders who can exert an invisible influence on employees with their sufficiently legitimizing personalities to captivate and improve communication between them and employees in understanding their needs (Gong et al., 2009). Thus, transformational leadership will create confidence and respect between leaders and employees (Boamah et al., 2018). In the concept of Knowledge-Based View, information technology can provide

facilities for implementing integration and aggregation of knowledge (Grant, 1996). Various empirical studies have provided a learning capacity (Hult et al., 2006; Hult et al., 2006) and a supply chain integration that is quite smooth across organizational boundaries that is difficult to match by competitors (Anderson et al., 2004). In addition, it can also stimulate the emergence of digitally supported supply chain integration (Rai et al., 2006).

Transactional and transformational leadership are expected to renew the organization, supporting an open culture useful for triggering and facilitating the emergence of change (Kang et al., 2015). Such openness is expected to encourage the emergence of an innovation initiative where transactional leadership and transformational leadership can assist an organization in exploring wireless IT competencies. They are expected to support the emergence of a culture conducive to the emergence of various experiments, creative problem-solving, and innovation (Rosing et al., 2011; Waldman et al., 2001). Transactional and transformational leadership can be considered crucial for companies and employees' willingness to experiment with implementing the application of their IT competencies. To achieve a synergy that integrates the innovation success chain of innovation in a product improvement and can generate exploitation and exploration of digital technology. In this case, contemporary wireless IT technology has identified the important role of cellular technology and wireless communication as a critical technological asset for digital transformation (Gurbaxani & Dunkle, 2019).

The impact of transformational and transactional visions and leadership styles is expected to be compatible with the various possible disruptive aspects of wireless IT. It can be considered a subset of enterprise IT capabilities and wireless IT competencies applied through transformational leadership to improve remote access and connectivity to technology hardware and various software process execution. When leaders agree when any subordinate appears to have low capability, they should be pressured to enhance the performance conditions of organizational members. This will stimulate the emergence of various additional innovative capabilities that will encourage the development of innovations in enhancing supply chain competencies realized through wireless IT competencies. In addition, leaders should always try to think about old problems to be solved in ways that are quite contemporary and always encourage members of the organization to re-examine various basic assumptions regarding their abilities. So this will potentially lead to the emergence of time coordination in their supply chain and the emergence of perceptions to rely on wireless technology as an extensive thing that must be covered in their supply chain that can be implemented in wireless. These actions can also have the potential to increase innovation capability. Thus, the proposed hypothesis is as follows:

H_1: *Transactional leadership has a positive effect on wireless IT competence.*

H_2: *Transformational leadership has a positive effect on wireless IT competence.*

H_8: *Wireless IT competence mediates the relationship between transactional leadership and innovation capability.*

H_9: *Wireless IT competence mediates the relationship between transformational leadership and innovation capability.*

2.3 Wireless IT competence, ambidexterity and sensing capability of supply chain management

In the context of supply networks that have been used globally, organizations can increase their innovation capabilities in various ways, including generating radical or discontinuous innovations that simultaneously seek to create exploitative efficiencies (Christensen et al., 2003; Eng et al., 2023). It can be considered a link that maintains the balance of an organization's exploration and exploitation strategy by creating the ability to engage in multiple exploration and exploitation events simultaneously (Raisch & Birkinshaw, 2008). Various disruptive properties of wireless IT will emerge as a sign in the form of unconventional applications to enhance exploratory learning in producing innovations that are quite radical compared to infrastructure innovations (Eng et al., 2023).

In exploitative learning, competence can enhance a concept of ambidextrousness by disrupting well-established routines and enabling companies to integrate specialized knowledge from different supply chain partners (Park et al., 2019). Wireless IT competencies can be used to integrate and coordinate the knowledge of various specialists in a supply chain without fixed physical boundaries (Grant, 1996). Wireless IT competence can expand various creations related to previous technological knowledge organisations possess to use their resources to achieve specific results (Cho et al., 2011). One example in the supply chain is the exploitation of important inventory knowledge while still developing the organization's IT capabilities (Musril et al., 2023; Syed et al., 2020).

It can be exemplified, among others, through digital technology, where information on the extranet can be accessed via wireless devices at any location. In addition, we can form a learning organization where this is considered essential in increasing innovation capabilities through wireless IT competencies. This can be realized in the form of increasing variety through various experiments. Taking risks and looking for alternatives. While exploration aims to develop benefits, gaps exist through wireless IT competencies. Based on these assumptions, it can be said that wireless IT competence intends to build on existing competency concepts by merging and integrating scattered resources (Eng et al., 2023; Mao et al., 2020). When organizations are involved in demand management in the supply chain, practitioners will usually try to convince dynamic and complex customer markets through wireless IT competencies. The concept of information that can be accessed anywhere provided by wireless IT will encourage the emergence of demands for quality changes from the demand side, which can fluctuate from time to time. Thus, the supply chain must recognize the demand-sensing capabilities activated by various

monitoring and analyses carried out by social media (Lee et al., 2018). We have seen that small changes on the customer side can be amplified as we move through different segments of the supply chain (Lee, 1995). When an organization can identify any incremental changes in its customer base by monitoring and scanning through information technology, the gains in sensing capability and the value after that can increase exponentially, bringing benefits to the organization. This conclusion is supported by several recent supply chain investigations (Aronow & Shamliyan, 2018).

Based on the above assumptions, this research has an area of focus on designing a value network based on the use of demand-driven wireless IT that will not only enhance their ability to sense, translate and deliver forms of governance but will also be able to strengthen collaborations from organizations with upstream suppliers in efforts increase their demand. Thus, the proposed hypothesis is as follows:

H_4: *Wireless IT competence has a positive effect on Ambidexterity.*

H_5: *Wireless IT competence positively affects Sensing Capability Supply Chain Management.*

2.4 Ambidexterity and Innovation Capability

From the knowledge-based view theory, innovation capability can be considered a terminus of organizational outcomes; this is seen from the point of view of exploration and exploitation of external knowledge (Nonaka & Von Krogh, 2009). Organizational innovation capacity in incremental innovation is related to the exploitation of existing knowledge, while the concept of radical innovation is associated with the exploration of new knowledge (Gatignon et al., 2002; Tushman & Anderson, 1986). Companies that can exploit and explore wireless IT content are quite high compared to their competitors (Yan et al., 2016). In the supply chain, capability in innovation can be considered as the result of a comprehensive recapitulation of organizational learning, especially in knowledge related to how to coordinate the production of existing technology in various locations and how to create an integration of various technologies (Zhou & Wu, 2010). Several studies have succeeded in showing empirical evidence and noting that most of the innovation comes from other internal organization units outside of the formal innovation unit (Jansen et al., 2012; Nambisan et al., 2017) and the environment and external sources such as supply chain supply (Fosfuri & Tribó, 2008). Other empirical studies have also demonstrated the existence of exploration and exploitation in manufacturing organization innovation (He & Wong, 2004).

Customer service using teams which have adopted standard and creative processes (Gilson et al., 2005), relatively simultaneous feedback learning related to investment fund companies (Bontis et al., 2002), as well as innovations in financial services that are exploitative and exploratory (M. Jansen & Vennes, 2006). This research provides a form of reflection on how companies will pursue innovation in organizational structure, leader behavior and strategy (Gibson & Birkinshaw, 2004). Ambidextirious companies will benefit from multiple levels of technology coverage and high diversity. It has been adapted to the idea of distribution and knowledge spread in the supply chain to produce a variety of quite complex products, such as knowing whether what they are making is to consumer tastes (Brusoni & Prencipe, 2001).

Previous studies have also demonstrated the ability to integrate supply chains. This supply chain integration capability can be implemented in organizational learning processes and information processing (Song et al., 2022). The ability to explore and exploit a variety of external knowledge will be a critical study for innovative capabilities in a supply chain (Pennings & Harianto, 1992). When employees have real-time coordination in their supply chain and can offer location-based services relying on wireless technology, this creates a form of extensibility. It will encourage the creation of customer relationship management, which is expected to be integrated with work practices, work routines, and the normal parts of the work of members of the organization. The optimal implementation of wireless IT competencies within an organization will encourage the emergence of customer relationship management that can create performance and work support and optimize the development of new applications to support the customer relationship management program. It will encourage the implementation of innovation capability. Thus, the proposed hypothesis is as follows:

H_7: *Ambidexterity has a positive effect on Innovation Capability.*

H_{10}: *Ambidexterity mediating the relationship between Wireless IT Competence and Innovation Capability.*

2.5 Wireless IT Competence Dan Innovation Capability

Knowledge-Based Views and mobility dynamics have provided insight that is quite comprehensive regarding the nature of knowledge possessed by supply chain actors in functions that focus on supply chain mechanisms and integration as well as the responsiveness of organizational dynamics. As a supply chain integration competence from wireless IT, it will be able to produce an innovation capability through the supply chain, and this capability can be done anywhere and anytime. Wireless IT competence will be able to provide benefits from the internet, such as remote access in a short time and in real-time, with services that are continuously connected in the market chain. It aims to meet market demand online in any location.

Recent research has shown that technological capability positively relates to product innovation (Broadbent et al., 1999). Various capabilities influence the organization's supply chain innovation capability in implementing these technological competencies (Chen et al., 2014; Souitaris, 2002). In particular, the competence of Wireless IT can increase efficiency in providing functions to access information when needed in the rapid dissemination of organizational information throughout

the organization and when faced with being connected globally (Siau, 2004). Advances in wireless IT will be able to change practices in large settings that have been implemented so far. In addition, these practices will also experience similar changes (Christensen & Lægreid, 2006; Yadav & Pavlou, 2014).

This kind of effect will bring efficiency gains because chaos in the supply chain will be transformational in terms of exploratory learning and have a high impact on overall performance in the supply chain. Organizational capabilities are used to share and integrate knowledge through wireless IT competence. This is expected to produce a competitive advantage as an implementation orientation of dynamic capability by creating various causal ambiguities and replication barriers. Thus, the proposed hypothesis is as follows:

H3: *Wireless IT competence has a positive effect on Innovation Capability.*

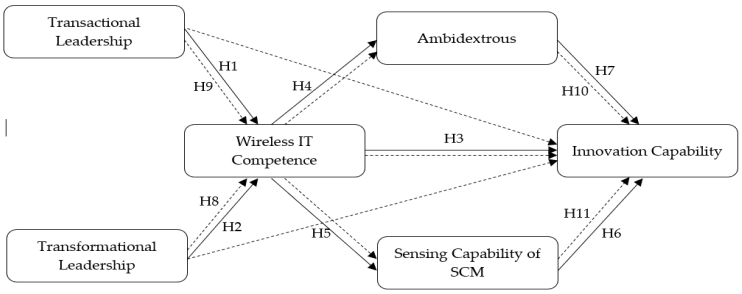
2.6 Sensing Capability Supply Chain Management, Wireless IT Competence and Innovation Capability

The system of procedures and managerial processes contained within the organization is expected to support every capability possessed by each member within the organization (Teece, 2007). It acts as a requirement in a supply chain operation. Furthermore, the low-level ability of each member of the organization will provide a pattern of differences that shows each member's ability (Teece, 2007). This low level of capability as long as it can be considered a practice between members in different supply chains. Organizational conditions of various disturbances will be used, and it can maintain the ability to provide value to end customers (Bhamra et al., 2011).

The dynamic capacity approach allows for a form of characterization of an operational capability. It is intended to improve the supply chain performance of managers and to bring out routine procedures and processes implemented within the organization throughout the supply chain. Sensing capability is an initial component of an organization's dynamic capabilities. This research attempts to contribute to the knowledge of dynamic capabilities in supply chain management. More importantly, this research attempts to conceptualize a new basis for public organizations to decide to acquire more dynamic capabilities.

While reviewing the literature, researchers conducted various studies of academic evidence related to capability building in supply chain management. The emerging literature identifies two fundamental characteristics in examining conceptions through sensing capability. We identify the first position of sensing capability as an antecedent in investigating its role in causality. Improving sensing capability performance is an antecedent of various consequences, including resilience and adaptability in the supply chain. Furthermore, it positively relates to the relationship between sensing capability and supply chain ambidexterity (Aslam et al., 2018).

Other researchers also make studies that focus on various anti-sensing and sensing capabilities as part of providing a feeling response collectively related to resilient supply chains and provide investigations regarding the direct role in their mediation to improve supply chain performance (Saeed et al., 2019). The weakness in some of the previous research literature when focusing on sensing capability is that there is little empirical evidence available that provides a link between sensing capability and supply chain management.



Note: ——▶ is direct effect
- - - - - - - ▶ is indirect effect

Fig. 1. Research Framework

From the point of view of the dynamic capability to be connected to the performance of this study, it has not been carried out by previous researchers. Regardless of the status of research on sensing capability, this research can still provide authentic evidence and is believed to be able to provide an increase in new technological advances. For example, wireless IT competence and the use of social media have had quite an impact on sensing capability and its measurement in management (Melnyk & Stanton, 2017). Ultimately, only supply chains can deliver location-based offerings, and wireless technologies are deemed critical in delivering such capture-related supplies, enabling an environmental scan to identify new business opportunities and periodically enabling exposure to the effects of changes in the business environment on customers. It has the potential to increase innovation capability positively. Thus, the proposed hypothesis is as follows:

H6: *Sensing Capability of Supply Chain Management positively affects Innovation Capability.*

H_{11}: *Sensing Capability of Supply Chain Management mediates the relationship between Wireless IT Competency and Innovation Capability.*

3. Materials and method

3.1 Sample and data collection technique

This study chose a merchant marine college as the sample to test our model based on various assumptions. The first reason is that the merchant marine college is a public sector that is expected to be able to produce various innovations to provide the best service. The second reason is that merchant marine colleges are expected to be able to produce graduates who are competitive in the competitive world of work. It must be adjusted to the innovation capabilities of the universities that produce these graduates. The third reason is that the target competition is quite competitive in becoming the best UPT, which is expected to stimulate various cognitive thoughts of higher education managers to produce the best performance. To determine the sample size used in this study, we refer to a study conducted by (Hair et al., 2006) using the structural equation modelling with 5 times the construct, which is considered a minimum sample size of 100.

This study uses a statistical power test level of 0.95. It is based on the assumption of the sample size on the calculator based on the sample size of the software using the 5 variable 8 structural model equation used in this study using a probability level of 0.05. Calculations using these rules obtained a sample size of 523. In this study, 600 were above the minimum sample rate, calculated from 397 to 600, so the sample adequacy level was considered sufficient (Hair et al., 2014). This study used a sample of 673 managers in 3 managerial classifications, top, middle, and bottom, in the technical service unit of the merchant marine college under the Indonesian Ministry of Transportation. Data collection was carried out using a questionnaire. In addition, we also interviewed managers. Then, we assessed their responses directly from 14 technical service units in the Indonesian Ministry of Transportation, so a total of 673 samples were obtained. The final sample of respondents comprises 39 female managers (33%). The age distribution in the sample (in years) is as follows: 18–25 (18%), 26–35 (19%), 36–45 (37%) and >46 (26%). The profile of education includes a college diploma (40%), bachelor's degree (38%), master's degree (14%) and doctorate (8%). The experience of managers in supply chain operations (in years) comprises 1–5 (21%), 6–10 (26%), 11–15 (17%), 16–20 (14%), 21–30 (17%) and >31 (5%).

3.2 Research Instruments

To get interval data, we develop a scale. This study uses the encoding technique introduced by (Nunnally, 1994). We do this to make it easier for respondents to capture the contents of the questionnaire in our research, and the numerical scale developed in this study is in the range 1 to 10. Innovation capability is measured using indicators from (Henderson & Clark, 1990; Tushman & Anderson, 1986). The transformational variable is measured based on the standard form (Chandrasekaran & Linderman, 2015). Meanwhile, the transactional leadership variable is measured using the standard form (Bass, 2000; Chandrasekaran & Linderman, 2015). For the wireless IT competence variable, we carry out a measurement scale based on (Afuah, 2002; Eng et al., 2023; Lee et al., 2018). For the ambidexterity variable, we use measurements based on (Gibson & Birkinshaw, 2004; Nemanich & Vera, 2009). The measurement is based on the sensing capability of supply chain management (Pavlou & El Sawy, 2011).

The data were analyzed using SEM-AMOS 25 to test a model proposed in this study to obtain a model and test our proposed hypothesis. Due to various factors, we chose scientific techniques to test this research model and these hypotheses. The first factor is equation-based work, where the same variable can represent a resort or predictor in one equation and regression criteria in another that suit the proposed research model (Nachtigall et al., 2003). The second factor is that it allows researchers to answer interrelated question attacks in a single systematic and comprehensive analysis and provides modeling of the relationship between several independent and dependent theoretical constructs simultaneously (Tarka, 2018). The third factor is the advantage of sending in an analysis that can test the mediation process simultaneously (Tabachnick et al., 2013).

4. Results

4.1 Construct Validity and Reliability

The confirmatory factor analysis in this study is used to evaluate the validity and briefly see the indicators used. To provide a measurement that is used when we find a data distribution that exceeds the normality criteria, it refers to the formula for providing treatment for data that is not normal in tone (Tabachnick et al., 2013). We adopt a negative-based solution with the Xn = 1/(k-X) formulation. It is expected to be able to provide normalized data distribution results. This research refers to (Arbuckle, 2016; Tabachnick et al., 2013). The average validity of the extracted variance or (AVE) to provide an evaluation regarding the quality level of the items in the conclusion construction obtained from the AVE value for each variable is at a value above the threshold of 0.5, and all items of standard factorial load are above (Bagozzi & Yi, 1988). We adopt the reliability criteria from (Arbuckle, 2016)(Arbuckle, 2016) where the value of each variable is expected to have a reliability above 0.7. From the measurement results, the reliability value of the variables was above 0.7, presented in Table 1 below.

Table 1
Result of Construct Validity and Reliability

Variable(s)	Item(s)	Std Loading	t-stat	Cronbach's Alpha α	Composite reliability
Transformational Leadership	a. Leaders in the organization always try to make other people commit to the implementation of the vision going forward	0.805	3.908	0.903	0.844
	b. Leaders always try to do more than just telling subordinates	0.907	5.125		
	c. Always strive to allow subordinates to think about old problems and compare them to new ones.	0.816	4.809		
	d. Leaders always try to re-examine some of the basic assumptions of subordinates.	0.893	5.032		
Transactional Leadership	a. Always tell subordinates what they need to know to do a job	0.841	3.911	0.903	0.917
	b. Leaders always show inappropriateness if subordinates display performance at a low level	0.882	4.903		
	c. Leaders always give subordinates freedom and flexibility in taking initiatives but do not encourage implementing them.	0.907	4.886		
Wireless Information Technology Competency	a. There is time in real conditions related to the existing supply chain	0.837	6.783	0.881	0.931
	b. The supply chain in the organization provides more preferences for location -based service offers	0.853	5.994		
	c. Wireless technology is more reliable in achieving extensification reached by Supply Chain	0.893	5.988		
	d. Coordination and integration efficiency can be achieved by using cellular technology	0.937	6.905		
	e. Personalization services produced by the organization can be improved with cellular technology	0.923	8.701		
	f. Wireless is considered crucial enough in the organisation's supply chain to create a competitive advantage.	0.954	7.886		
Ambidexterity	a. We provide added value to the supply chain through improvement and modification in operating the use of cellular technology	0.784	5.906	0.830	0.960
	b. We provide added value to supply through progressive adaptation related to the use of existing cellular technology	0.881	6.118		
	c. We adopt cellular technology intending to provide learning related to what has been done by others in	0.779	6.209		
	d. We use cellular technology as an effort to execute various efficient processes in the supply chain.	0.804	6.507		
	e. We provide an application related to the implementation of the use of new seller technology in our supply chains	0.773	6.338		
	f. We encourage the use of cellular technology to produce various experiments to form a management and arrangement in supply chain inventory	0.907	7.054		
Sensing Capability Supply Chain Management	a. Identification of new business opportunities through environmental scanning	0.778	5.886	0.886	0.932
	b. Ascertain what the customer wants through a review of new product development efforts	0.805	5.92		
	c. Improvement of existing products and implementation of ideas for the creation of new products through an optimal time out of time.	0.911	6.003		
	d. Periodic review of cheating changes in the business environment to customers	0.823	6.195		
Innovation Capability	a. We encourage the creation of additional innovation capabilities	0.819	0.934	0.954	0.914
	b. Developing innovation as an effort to strengthen the competency of the supply chain	0.905	0.916		

Table 1 summarises the composite reliability (CR), average variance extracted (AVE), and the correlation coefficients between the constructs. Table 1 indicates that the CR of all constructs is above 0.70, with the AVE value ranging from 0.729 to 0.839. The discriminant validity assessment was conducted per the Fornel and Larcker (1971) approach by comparing the squares of the root of each AVE on the diagonal and the correlation coefficient (off-diagonal) for each of the constructs in

question. The construction of each concept evinces minimal disagreement. However, the discrepancy is insufficiently pronounced. In conclusion, the discriminant validity of this measurement model is satisfactory, and the discriminant validity between constructs is also demonstrated in Table 2.

Table 2
Result of Discriminant Validity

No	Construct(s)	1	2	3	4	5	6
1	Transformational Leadership	0.825					
2	Transactional Leadership	0.729**	0.786				
3	Wireless Information Technology Competency	0.708**	0.691**	0.782			
4	Ambidexterity	0.801**	0.724**	0.779**	0.751		
5	Sensing Capability of Supply Chain Management	0.792**	0.785**	0.741**	0.713**	0.794	
6	Innovation Capability	0.671**	0.694**	0.753**	0.701**	0.761**	0.749

It was carried out in a three-step process to test the models and hypotheses proposed in this study. The first step is to test the goodness of fit. The model proposed in this study will be evaluated. The statistical analysis will be carried out in three stages to test the model and hypothesis proposed in this study. The first process is the goodness of fit test, which tests the model's feasibility and evaluates the research model's acceptance. Table 3 shows a CHI SQUARE value of 87.39, significance is 0.00, GFI is 0.911, NFI is 0.902, CFI is 0.931, TLI is 0.902 and RMSEA value is 0.03. According to (Arbuckle, 2016; Tabachnick et al., 2013), this evaluation procedure results in the receipt of capital and further analysis to test the hypotheses that we have proposed

Table 3
Goodness of Fit Testing

The Goodness of Fit Test	Cut off Value	Result	Conclusion
Chi-square for df=144, sig. at 5%	331.19	80.957	Not fit
P-value	≥0.05	0.000	Fit
GFI	≥0.90	0.915	Fit
MFI	≥0.90	0.908	Fit
TLI	≥0.90	0.982	Fit
CFI	≥0.90	0.937	Fit
RMSEA	0.03-0.08	0.041	Fit

4.2 Hypothesis testing

As shown in Table 4, all the hypotheses proposed in this study were accepted. Finally, we also tested the mediation hypothesis. We adopted a four-step testing procedure for the 4 proposed mediation hypotheses, as explained by (Baron & Kenny, 1986). It produces a regression weight with a significance of 0.712, and then, for the second step, the regression of the independent variable on the mediating variable of 0.479 is performed. The third step is for the mediating variable on the dependent variable to obtain a significance weight of 0.554 and finally re-running the regression of the independent variable on the dependent variable by including the mediating variable, which increases with a value of 0.808 and is significant at 5% significance level. This test examined the mediating effect of transformational leadership on wireless IT competence and innovation capability. Produces a regression weight that has a significance of 0.706. Then, the second step is the regression of the independent variable on the mediating variable of 0.651. The third step is for the mediating variable on the dependent variable to obtain a significance weight of 0.659 and finally re-running the regression of the independent variable on the dependent variable by including the mediating variable, which increases with a value of 0.794 and is significant at 5% significance level. This test examined the mediating effect of transactional leadership on wireless IT competence and innovation capability.

It produces a regression weight that has a significance of 0.801, and then the second step is the regression of the independent variable on the mediating variable of 0.795. The third step is for the mediating variable on the dependent variable to obtain a significant regression weight of 0.881 and finally rerunning the independent variable regression on the dependent variable by including the mediating variable increasing with a value of 0.892 and significant at a 5% significance level. Testing the effect of this mediation was conducted to examine the role of mediation between the wireless it variable competence and ambidexterity on innovation capability. It produces a regression weight with a significance of 0.783, and then the second step is the regression of the independent variable on the mediating variable of 0.692. The third step is for the mediating variable on the dependent variable to obtain a significance weight of 0.774 and finally re-running the independent variable regression on the dependent variable by including the mediating variable increasing with a value of 0.852 and significant at a 5% significance level. This test examined the mediating effect of wireless IT competence on sensing capability supply chain management on innovation capability.

Table 4
Result of Hypothesis testing

Hypothesis	Std. Estimates	Estimate	Std. error	Critical Ratio	Sig.	Conclusion
H1: Transformational Leadership → Wireless IT Competence	0.783	0.562	0.194	8.136	0.00	Accepted
H2: Transactional Leadership → Wireless IT Competence	0.519	0.839	0.226	7.431	0.000	Accepted
H3: Wireless IT Competence → Innovation Capability	0.710	0.716	0.994	8.397	0.00	Accepted
H4: Wireless IT Competence → Ambidexterity	0.804	0.489	0.288	5.139	0.00	Accepted
H5: Wireless IT Competence → Sensing Capability of SCM	0.691	0.503	0.194	2.834	0.00	Accepted
H6: Sensing Capability of SCM → Innovation Capability	0.772	0.809	0.091	3.248	0.00	Accepted
H7: Ambidexterity → Innovation Capability	0.608	0.903	0.084	6.791	0.00	Accepted
H8: Transformational Leadership→ Wireless IT Competence→ Innovation Capability						Accepted
P(1) : IV → DV	0.712	0.243	0.114	4.281	0.000	Accepted
P(2) : IV → MV	0.479	0.289	0.096	4.068	0.000	Accepted
P(3) : MV → DV	0.554	0.337	0.108	3.931	0.000	Accepted
P(4) : IV → DV	0.808	0.406	0.141	3.048	0.000	Accepted
H9: Transformational Leadership → Wireless IT Competence → Innovation Capability						Accepted
P(1) : IV→DV	0.706	0.234	0.039	4.786	0.000	Accepted
P(2) : IV→MV	0.651	0.551	0.081	5.917	0.000	Accepted
P(3) : MV→DV	0.629	0.308	0.093	8.063	0.000	Accepted
P(4) : IV→DV	0.794	0.443	0.088	7.124	0.000	Accepted
H10 : Wireless IT Competence → Sensing Capability of SCM → Innovation Capability						Accepted
P(1) : IV→DV	0.801	0.406	0.084	4.553	0.000	Accepted
P(2) : IV→MV	0.795	0.531	0.103	5.124	0.000	Accepted
P(3) : MV→DV	0.881	0.548	0.092	5.908	0.000	Accepted
P(4) : IV→DV	0.892	0.609	0.096	6.327	0.000	Accepted
H11: Wireless IT Competence → Ambidexterity → Innovation Capability						Accepted
P(1) : IV→DV	0.783	0.607	0.098	3.924	0.000	Accepted
P(2) : IV→MV	0.692	0.581	0.087	4.118	0.000	Accepted
P(3) : MV→DV	0.774	0.598	0.104	4.329	0.000	Accepted
P(4) : IV→DV	0.852	0.602	0.113	4.408	0.000	Accepted
Total effect size:						
Transformational leadership → Innovation Capability						0.672
Transactional leadership → Innovation Capability						0.778
Wireless IT Competence → Innovation Capability						0.893
Amberdixterity → Innovation Capability						0.801
Sensing Capability of SCM → Innovation Capability						0.553

Evaluation of strategic paths in increasing innovation capacity can be analyzed by comparing the total effect of the variables contained in the structural model of this study. The total effect of the transformationality variable on innovation capability is 0.672. The total effect of the transactional leadership variable on innovation capability is 0.778. The total effect of the wireless IT competence variable on Innovation capability is 0.893. The total effect of the ambidexterity variable on innovation capability is 0.801. The total effect of the sensing capability of supply chain management is 0.553, which shows the important role of incorporating a mediation concept in bridging influences that increase innovation capability. It shows the importance of the strength of the anti-sedun variables, which are bridged by mediating variables in increasing innovation capability.

5. Conclucion and theoretical implications

In conclusion, many studies have empirically provided a relationship between the application of information technology and antecedents in supporting increased organizational performance. However, the intersection of a technological finding and a leadership concept that can bring about changes in developing innovative capabilities in relationships has not found many empirical results. This research seeks to build an effort to increase innovation capability through transactional and transformational leadership roles that are used to encourage wireless IT organizational competence and sensing capability. Supply chain management uses survey data analysis from public organizations, such as the merchant marine college technical service unit under the Indonesian Ministry of Transportation. This study seeks to explore the relationship between antecedent variables in increasing the consequence variable, namely innovation capability, which has succeeded in demonstrating an acceptance of the model used to increase innovation capability, and all hypotheses proposed are accepted.

The theoretical implications of these findings provide a review showing that transformational and transactional leadership will have a sufficiently positive impact on wireless IT competencies that can provide a link to increase innovation capability (Eng et al., 2023). This study also succeeded in providing empirical evidence that various transactional and transformational leadership attributes would provide the possibility for increasing IT wireless competence to provide increased innovation capability. This finding extends the perspective and theoretical contribution to the knowledge-based view and dynamic capability theory. This finding also provides a new contribution to research related to ambidexterity, which is considered a mechanism for integrating enterprise knowledge with supply chains constrained by competent wireless IT that is not only based on new technology ownership. Studies from previous researchers have also provided a perspective that organizational aspects cited by managers can be considered one of the main obstacles to the successful deployment of new technologies (Kiron, 2017). Organizational technology integrates knowledge, so this study is expected to provide direction for the emergence of diffusion in the supply chain, which is the main determinant of innovation supporting new technologies (Gupta & George, 2016). These results provide three reviews that show that transformational leadership and transactional leadership

through wireless IT competencies can facilitate a process, including innovation capability and sensing capability of supply chain management.

Existing technological capabilities are expected to help companies quickly identify new technological trends. However, it is hoped that this increase in the accumulation of technological capabilities will also contribute to companies establishing a series of organizational routines that tend to impact the emergence of explorative innovation restrictions (Zhou & Wu, 2010). This also illustrates that this study tries to limit the limitations of previous research where transformational and transactional capability behaviors will be able to complement wireless IT competencies and provide possibilities for the exploration of radical innovations and exploitation of infrastructure innovation (Grover et al., 2018; Syed et al., 2020).

This research also contributes to developing wireless IT competence as an organizational capability viewed at a high level. Wireless IT competence can be considered a facility of transformational and transactional capabilities towards ambidexterity and the sensing capability of supply chain management to support various strategic pursuits in exploratory learning systems. It aims to generate new ideas and form a fairly rapid integration of information into knowledge. It is also hoped that this will simultaneously provide the possibility of a flow of exploitative learning knowledge integrated with the integration of revisions from various existing or existing knowledge in innovations carried out in stages (Rosing et al., 2011). Although the concept of exploratory learning and exploitation has been studied in the concept of leadership ambidexterity to produce transactional and transformational leadership, the dimensions of wireless IT competence are expected to increase the dissemination of interactional knowledge and the involvement of exchanges in knowledge sharing.

The emergence of dynamic capability considered a reflection of wireless IT competence, is expected to strengthen supply chain efforts in reducing response delays and providing capability creation. It can be realized in real-time reflection on a fashion trend moving quite progressively. The findings of this study are expected to contribute to the IT technology and information systems literature through knowledge-based view theory and dynamic capability. It can be recognized as an important aspect of transformational and transactional leadership behavior, which is expected to accelerate the dissemination of information. This research also contributes to advancing the concept of digital leadership based on digital transformation (Peshawaria, 2018).

Based on this contribution, we can assume that wireless IT competence can promote knowledge access and emerging technology diffusion. It can occur among members and can increase the tendency of companies to explore something new related to the emergence of external knowledge (van den Bosch & Van Wijk, 2001). Transformational and transactional leaders will be able to inspire and stimulate change and are in a better position to turn IT investments into efforts to realize competitive advantage through Wireless IT competence and sensing capability of supply chain management. Transactional and transformational leaders are expected to build trust and commitment between the organization and its members. The results of this study are expected to provide an expansion of the role of IT in organizations and consideration of transformational leadership behavior and its influence on increasing innovation capability. This is quite important because transformational and transactional leadership will motivate organizations to generate innovation and align their business strategies through the emergence of digital transformation (Bhardwaj & Punia, 2013).

We can see that sensing capability in supply chain management will increase dramatically when innovation capability is carried out by public organizations such as technical implementing units under the Indonesian Ministry of Transportation, which will increase from a low level to a moderate level. However, when the potential of this substance decreases continuously, this will impact increasing activity in the emergence of scanning of the role of suppliers. It is better for consumers when suppliers scan through various communication media, such as social media, as it is hoped that supply chain practitioners will get different results. It means that the expected sensing capability does not change significantly when scanning activity increases from low to moderate. However, progress will be considered if the existing managers provide upgrades and scans to their innovation capabilities. The dynamics in this public organization, as well as leaders and managers in supply chain management, should not only provide benefits from the communication side but also see their dynamic capabilities. However, the more important aspect is understanding that high sensing capability does not come naturally but comes from scanning their activity. It can be driven by the role of wireless IT competencies that can drive existing financing concepts so that they can realize innovation capability.

This research is expected to provide a combination of supply chain management for public organizations that are more active in helping these organizations realize their targets. The achievement of optimal sensing capability will impact radical innovation. It will encourage efforts to form a competitive advantage when they seek to create new technologies that are expected to place them superior to other public organizations. The environmental variations will encourage practitioners to consider that combining public organization management concepts will help strategic decision-making regarding their roles and objectives in producing innovation capability.

The practical implications of this study are expected to have various practical benefits for investment practitioners in technology and information. Hopefully, it will become a reference, especially in sophisticated technology, with consequences that encourage more than technical progress. Still, this technological progress due to investment in the IT sector must complement transformational leadership behavior and transactional leadership. This research shows that wireless IT competencies are expected to provide facilities and completeness for developing innovative capabilities with various

antecedents. To increase it, among others, with transformational and transactional leadership and sensing capability. It is integrated into the context of consistency with an emphasis on transactional and transformational leadership, which is expected to be able to leave conservative ways and is expected to lead to the adoption of new ways of providing solutions to behavioral problems. With transactional and transformational leadership, it is expected to be a driving force for the emergence of the alignment effect of strategy with IT competence.

In other words, we can provide a point of view that transactional and transformational leadership are expected to act as catalysts for innovation, and therefore, wireless IT competencies will be able to act as a means that opens up various opportunities. The opportunity can be obtained from a wireless IT competence in a different perspective, such as factual access to supply chain information, which is quite important at the level of direct inventory and product performance. In addition, fast and accurate customer service through various tracking and product specifications produced by the organization will form the ability to coordinate and integrate various information and knowledge that appears instantly.

This research can also recommend that managers obtain new technology support based on transformational and transactional leadership behavior to design an improved framework to increase innovation capability. Transactional and transformational leadership are expected to have various attributes that can assist companies in setting new technology standards. Managers must benefit from the emergence of wireless IT competencies. The supply chain networks in the concept of sensing capability have spread where it is expected to have consistency with organizational boundaries that have developed rapidly and are quite liquid in digital supply chains. Holistically, developing a knowledge-based view and dynamic capability will provide an organizational perspective for promoting various capability perspectives. An organisation's knowledge and technology can become competitive in information systems strategy and informatics engineering over time. Thus, it is hoped that transformational leadership and transactional management can assist companies in adapting and responding to global uncertainties and environmental changes.

6. Limitation and future research

This study has various limitations on the data collected, linked to the organization's internal and external supply chains tailored to the needs of developing a research model based on the emergence of variables. Future research could consider companies operating in different industries outside of the firm-focused relationship used in this research. This study has various limitations, especially the mediating role of wireless IT competence in the context of public organizations. Future research is expected to compare the findings with the findings of this research in the context of quite dynamic captions, for example, in high-tech industries where virtual supply chains and e-commerce activities will become commonplace. Future research can conduct various case studies to deepen and test how transformational and transactional leadership and management influence the innovation process of sensing capability in a supply chain context.

Data Availability

The data used in this research is sensitive, so data sharing does not apply to this research.

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