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Enhancing Digital Literacy in Supply Chain Management: A Case Study of an Indonesian Port Corporation

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Full research paper

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Abstract

The extant literature has identified that the ongoing digitalisation of port operations, specifically in developing countries around the globe, is inhibited by stakeholder resistance stemming from digital literacy limitations. This study aims to assess and develop strategies to improve the digital literacy of stakeholders involved in port operations through a case study with an Indonesian Port Corporation. We found a gap between the digital literacy level expected by the port management and the digital literacy levels of employees. We discuss several antecedents to this problem and subsequently propose a set of recommendations to address the gap identified. These recommendations include establishing in-house training, scholarship programs, employee exchange program, and using the digital literacy assessment framework proposed in this study to monitor any uplift in digital literacy levels. This study offers important implications for research and practice related to digital literacy in the context of supply chain management in developing countries.

Keywords: digital literacy, supply chain management, port operation

1 Introduction

The advancement of digital technologies has increased the criticality of digital literacy as a factor in social wellbeing (Peng et al. 2021). This is also true in the context of supply chain management (SCM), where the usage of digital technologies is ubiquitous in the enhancement of efficiency, effectiveness, and resilience of supply chains (Ngai et al. 2011; Wicaksana et al. 2021). Importantly, business organisations should have the prerequisite foundational and SCM-related digital literacy to realise the benefits of technological advancement in SCM (Kurnia et al. 2019; Yao et al. 2022). This is extremely significant for companies operating in developing countries that generally have insufficient digital literacy capacity to exploit opportunities offered by technological advancement (Kurnia et al. 2015).

Indonesia, as an example of a developing country, must develop its foundational digital literacy capability to maximise exponential growth in its digital economy (Basnett et al. 2020). In a similar vein, there is a need to assess and develop the level of SCM-related digital literacy of stakeholders involved in supply chain processes, as the supply chain is the backbone of Indonesia's current booming digital economy (Tiwari and Ali 2021). Specifically, supply chains rely heavily on port operations because of the geographical characteristics of Indonesia as an archipelagic country (Verhaeghe et al. 2021). Consequently, digitalisation of port operations has become the main focus of current government strategy to increase the nation's logistics performance index (Basnett et al. 2020; Verhaeghe et al. 2021).

Examination of the extant literature has identified that the ongoing digitalisation of port operations in developing countries around the globe, including Indonesia, is inhibited by stakeholder resistance attributable to digital literacy limitations (Brunila et al. 2021). Motivated by this problem, our study aims to improve the digital capability of Indonesia's port operations by assessing the digital literacy level of port employees and identifying strategies to enhance the current digital literacy. Specifically, our research questions are: (1) What are the current and expected foundational and SCM-related digital literacy levels in managing port operations in Indonesia? and (2) How can the current levels of foundational and SCM-related digital literacy of port employees in Indonesia be improved?

To answer these questions, we conducted an in-depth case study with a state-owned enterprise that manages port operations in eastern Indonesia. Our case study involves both qualitative and quantitative data collection. We applied a digital literacy readiness model framework in the context of SCM proposed by Kurnia et al. (2022) to assess the digital literacy level of port employees through an online survey. We then conducted focus group discussions (FGD) with the management team to understand the required digital literacy level as perceived by the port management. This helped us identify the gap between management expectations and current employee capability. Finally, we reflected on the overall findings of the literature and developed a practical roadmap of foundational and SCM-related digital literacy development for port operations in Indonesia.

Our study shows that there is a gap between the digital literacy level expected by the port management and that held by employees. We identified several underlying causes for the existence of this gap and subsequently developed a set of recommendations for the port management to close the gap. These findings contribute to the body of knowledge by providing a specific evaluation and development pathway for digital literacy that includes foundational skills and SCM-related competencies in the context of port operations in a developing country. It also provides empirical evidence on the linkage between digital technologies and SCM operations, particularly by showing the level of digital literacy that are requisite for stakeholders involved in logistics to ensure the effectiveness of supply chain operations.

The next section presents a review of previous related studies on digital literacy assessment, followed by a brief description of the digital literacy framework applied in this study. We then describe the research methodology and present the study findings. We conclude the paper by outlining our study implications for research and practice, as well as proposing a set of recommendations to improve the foundational and SCM-related digital literacy of stakeholders involved in port and logistical operations in Indonesia as an example of a developing country.

2 Literature Review

Digital transformation is critical for an organisation to ensure its competitive advantage (Verhoef et al. 2021). However, it seems that most of the existing studies focus on the strategies to perform digital transformation and provide little attention to employees as the actors within the firm who execute those strategies (Murawski and Bick 2017). In fact, employees' digital literacy is critical for the success of digital transformations since digital transformation involves the deployment of new hardware and software and requires new skills to adapt to major organisational changes (Kozanoglu and Abedin 2020;

Murawski and Bick 2017). Employees have to be ready for, and become part of, the transformation itself. Furthermore, studies have highlighted that the digital literacy level of employees is linearly correlated with the resistance to digital transformation, particularly in resisting a new mindset of a digital way of working (Murawski and Bick 2017). In fact, Khan and Vuopala (2019) suggest that employees' digital literacy level might become a key determinant of their survivability during digital transformation. Therefore, assessing the digital literacy level of employees at the organisational level is particularly imperative.

Numerous studies have provided examples of digital literacy assessment. However, most of them focus on the education context (Vuorikari et al. 2016) and provide little information on the assessment process in the organisational context (Kozanoglu and Abedin 2020). Within this niche, most of the studies are conceptual in nature (Littlejohn et al. 2012; Wagner et al. 2014). In addition, within empirical studies that assess digital literacy at the organisational level, the assessment indicators tend to be quite general and do not assess the specialised digital literacy indicators derived from the work context (Ei and Soon 2021). For example, an empirical study by Bartolomé et al. (2018) relies on "The Digital Competence Framework for Citizens" of the European Union to assess digital literacy at the organisational level. This framework focuses on general aspects of digital literacy, particularly computer literacy (Vuorikari et al. 2016). As such, the study frames digital literacy level as the level of computer skills possessed by the employees, regardless of the fitness of that set of skills to the requirement for performing the job satisfactorily. We strongly believe that accounting for the unique nature of the work context is critical in assessing digital literacy at the organisational level. For example, an employee in the banking industry might be better off with a high-level understanding of digital technologies specifically used in the accounting process rather than generic digital technologies to support other business processes (Sardana and Singhanian 2018).

Our literature analysis indicates that there is a paucity of digital literacy assessment applied in the organisational context. Furthermore, current literature provides limited guidance on assessing digital literacy that considers the nature of the business process within the organisation. This study is intended to fulfil these gaps by performing a digital literacy assessment in the organisational context, specifically related to supply chain management business processes.

3. Digital Literacy Assessment Framework

Currently, there are several existing foundational digital literacy frameworks developed by public sector/government and private sector institutions, including the European Union (Vuorikari et al. 2016), British Columbia Government (British Columbia Ministry of Education 2013), Australian Government (McLean et al. 2020), Singapore Institute of Policy Studies (Ei and Soon 2021), McKinsey (Doni et al. 2021), and Pearson IC3 Digital Literacy Certification (Pearson 2021). Each framework provides some commonalities and is complementary in nature. However, these frameworks do not examine the digital literacy level in a specific context, such as supply chain management and port operations. Kurnia et al. (2022) address this issue by developing a digital literacy framework in the context of supply chain management based on thematic analysis and a comprehensive literature review (Table 1). The framework consists of eight competencies for foundational digital literacy and one competency for SCM-related digital literacy. Specific to SCM-related digital literacy, this framework assesses four elements namely SCM digital learning, proficient use of SCM-related software, awareness to SCM issues, and data analytics in SCM-context. We used this framework in our analysis because it is developed from well-established digital literacy frameworks around the globe. In addition, the elements of SCM-related digital literacy in this framework are comprehensive and derived systematically from 13 articles published in top tier SCM journals.

Competencies	Elements	Sources
Computational and Algorithmic Thinking	1. Tech translation and enablement	MK; AUS; EUR;
	2. Structured problem solving	MK; SIN; CAN
	3. Digital innovation	SIN; EUR; CAN
Digital Communication and Collaboration	1. Digital information sharing	MK; AUS; EUR; SIN; CAN; PEAR
	2. Involvement in online community	SIN; EUR; CAN
	3. Digital expression	CAN; PEAR
Digital Content Fluency	1. Digital content creation	EUR; SIN; CAN; PEAR
	2. Digital content combination	EUR; SIN; CAN
Digital Citizenship	1. Digital ethics	EUR; CAN
	2. Environmental ethics	CAN
	3. Creative credit and copyright	MK; AUS; EUR; CAN; PEAR
	4. Cyberbullying	EUR; SIN; CAN
	5. Balanced attitude towards technology	CAN; PEAR
Digital identity and Safety	1. Device security	MK; AUS; EUR; SIN; CAN; PEAR
	2. Digital footprint and reputation	EUR; SIN; CAN; PEAR
	3. Digital well-being	AUS; EUR; SIN; PEAR
Digital Learning	1. Learning about and with digital technologies	MK; CAN
	2. Continuous learning	SIN; CAN
	3. Self awareness	EUR; SIN
Technology Concepts and Operations	1. Basic digital concepts	CAN; PEAR
	2. General digital technology use	MK; AUS; SIN; CAN
	3. Device troubleshooting	AUS; EUR; CAN; PEAR
Data and Information Literacy	1. Information gathering	SIN; CAN
	2. Information searching	AUS; CAN; PEAR
	3. Information filtering	CAN; PEAR; EUR; SIN
	4. Information processing	MK; EUR; SIN; CAN; PEAR
SCM-related Digital Skills	1. SCM digital learning	Birou et al. (2021); Gupta et al. (2021); Stek & Schiele (2021); Esser et al. (2020); Pekkanen et al. (2020); Flöthmann et al. (2018); Sun & Song (2018); Tatham et al. (2017); Lin & Chang (2018); Sinha et al. (2016); Dubey & Gunasekaran (2015); Lorentz et al. (2013)
	2. Proficient use of SCM-related software	
	3. Data analytics in SCM context	
	4. Awareness to SCM issues	

Table 1 Foundational and SCM-Related Digital Literacy Assessment Framework
(Kurnia et al. 2022, p.4)

3 Methodology

We utilised a case study approach employing both quantitative and qualitative data collection procedures. The data are collected in parallel, analysed separately, and then triangulated to provide a comprehensive understanding of the phenomenon of interest (Onwuegbuzie and Teddlie 2003). The qualitative data were obtained through focus group discussions (FGD) and document analysis, while quantitative data was obtained through surveys. The data collection and analysis were conducted from April to May 2022.

We divided the research methodology into three components. First, we investigated the current level of foundational and SCM-related digital literacy level of the port employees by administering an online survey. Second, we administered the same questionnaire and performed an FGD with the port management to identify the expectation from the management in regard to the expected digital literacy level required for effective port operations. Importantly, we look for potential improvement interventions to raise the digital literacy level to align with management expectations. Guided by Kurnia et al.'s (2022) digital literacy framework (Table 1), we developed survey items and FGD questions to assess the level of foundational and SCM-related digital literacy of a state-owned enterprise that manages the port operation in Eastern Indonesia. We transformed the Likert scales in the employee survey data into numerical data and created a frequency table to obtain the average scores of each digital literacy indicator. We then aggregated these values to obtain an index of the digital literacy level of the employees. Textual data from the focus group discussion was analysed through open coding to identify text segments that provide information on the management's expectation of digital literacy level and feasible strategies to improve the current digital literacy level from the perspective of port operator management.

In the third stage, we performed a gap analysis by comparing the current digital literacy level and expectations from the port management to understand in more detail which competencies or elements need to be improved. We calculated the differences in digital literacy scores between the employees and management and then identified elements with the highest discrepancy. Following that, we also recalled insights from our FGD session with management and performed a comprehensive literature review to develop an improvement roadmap for foundational and SCM-related digital literacy levels for port operations.

4 Findings and Discussion

In total, we received 47 employee responses to our survey. Approximately 83% of our respondents were male, representing the dominant gender of the workforce in the case organisation. In addition, around 62% of the respondents held bachelor's degrees, followed by senior high graduates, diplomas, and vocational training graduates. This composition implies that most employees have adequate education qualifications to fit with managerial-related tasks. Around 80% of the total respondents have been working in the case organisation for six months to 10 years, indicating that young employees dominate the workforce. In addition, we perform an FGD session with the management representatives from the Human Resources department of the case organisation.

4.1 Foundational and SCM-related Digital Literacy Level

In terms of digital literacy level, our study findings indicate that the foundational and SCM-related digital literacy indicators of the employees are generally low although the port management has a high expectation for all indicators. Table 2 provides the summary of the findings.

Digital Skills Dimension	Digital Competence Element	Index
1. Technology Concepts and Operations	1.1. Basic digital concepts	0.8468
	1.2. General digital technology use	0.9021
	1.3. Device troubleshooting	0.7830
	1.4. Make informed decisions	0.8085
2. Digital Learning	2.1. Learning about and with digital technologies	0.8851
	2.2. Continuous learning	0.8596
	2.3. Self-awareness	0.8383
3. Computational and Algorithmic Thinking	3.1. Tech translation and enablement	0.4277
	3.2. Structured problem solving	0.4681
	3.3. Digital innovation	0.4213
4. Data and Information Literacy	4.1. Information gathering	0.7745
	4.2. Information searching	0.8468
	4.3. Information filtering	0.7830
	4.4. Information processing	0.7319
5. Digital Communication and Collaboration	5.1. Digital information sharing	0.8468
	5.2. Involvement in online community	0.7447
	5.3. Digital expression	0.7617
6. Digital Content Fluency	6.1. Digital content creation	0.7702
	6.2. Digital content combination	0.7702
7. Digital Citizenship	7.1. Digital ethics	0.7532
	7.2. Environmental ethics	0.7660
	7.3. Creative credit and copyright	0.8596
	7.4. Cyberbullying	0.8340
	7.5. Balanced attitude toward technology	0.8340
8. Digital Identity and Security	8.1. Device security	0.8936
	8.2. Digital footprint and reputation	0.8085
	8.3. Digital wellbeing	0.8766
9. SCM-Related Competences	9.1. SCM digital learning	0.6043
	9.2. Proficient use of SCM-related software	0.3660
	9.3. Awareness of SCM issues	0.3660
	9.4. Data analytics in the SCM context	0.3660

Table 2 Employees' Digital Literacy Level

The score for each digital literacy indicator is assessed based on a scale of 0 to 1. For the digital skill assessment of employees, 0 denotes “very low”, while 1 denotes “very high”. For the management expectation, 0 implies “not important”, while 1 implies “very important”. Details of the findings are elaborated below.

Low level of employees’ foundational and SCM-related digital literacy

Our survey reveals that scores for various indicators of digital literacy level among employees are quite sparse on a scale of 0 to 1 (Table 2). Overall, the employee digital literacy level is 0.74. The employees score highest in digital learning (0.86) and digital identity and security (0.86). At the same time, they are significantly lacking in computational and algorithmic thinking (0.47) and SCM-related competencies (0.46).

High scores in digital learning and digital identity and security might be related to the nature of these competencies, which will increase along with users' exposure to digital technologies (Dondi et al. 2021). Hence, the characteristics of our respondents as young people that have better exposure to digital technologies compared with the older generation (Wang and Wu 2021) might influence these indicators. In contrast, low scores in computational and algorithmic thinking and SCM-related competencies might be related to the exposure of respondents to specific types of work. For example, computational and algorithmic thinking is needed for the employee to translate a strategic plan into improvements in day-to-day operations (Dondi et al. 2021). Similarly, SCM-related competency is required when employees have to think holistically about the supply chain beyond logistics and port operations (Birou et al. 2021). Both types of work might be less frequent in respondents' daily tasks. As such, both competencies might be overlooked.

High expectations for all indicators of foundational and SCM-related digital literacy

In the survey with the port management, we found that most of the digital literacy indicators are perceived to be either very important (1 out of 1) or important (0.8 out of 1). Overall, management expects employee digital literacy levels to be at least equal to 0.92 on a scale of 0 to 1. In particular, management expects that several competencies of digital literacy, such as technology concept and operation, data and information literacy, digital communication and collaboration, and SCM-related competencies, should score higher than the average value (i.e., 0.92).

Our textual data from the FGD session with the management triangulates the survey responses and increases the richness of information regarding the management expectation. A similar point about the importance of the employees' digital literacy level is also stressed in the data, as outlined in the following excerpt:

“Employees need to increase their management and digital literacy capabilities. There are so many activities that are completed manually, which in our view, become inefficient.” – Participant 1

“Knowledge and skills related to information and communication technology (*emphasising digital literacy*) are really needed these days ... considering management’s initiative to reduce logistics cost” – Participant 2

This finding implicitly highlights that the management of the port operator already recognises digital literacy’s criticality in their business process. It also aligns with research showing digital literacy as an influential and increasingly critical capability to enable individuals to participate in the contemporary workforce (Joyce 2019).

4.2 Gaps in Foundational and SCM-Related Digital Literacy

Based on our assessment of the employees’ and management expectations of foundational and SCM-related digital literacy, we identified two important gaps as discussed below.

Inadequate fit of foundational and SCM-related digital literacy

First, the discrepancy between management expectations and employees’ current level of digital literacy, as depicted in Figure 2, shows that the employees’ current digital literacy has an inadequate fit with management expectations on most of the digital literacy indicators. We then looked at our survey items (Table 2) in detail to identify specific elements of each competency that need to be improved. We found that five out of nine competencies (i.e., technology concepts and operations, data and information literacy, digital communication and collaboration, digital content fluency, and digital citizenship) need slight improvement to be on par with the management’s expectations. Importantly, two out of nine

indicators must be significantly improved to satisfy management requirements, which are computational and algorithmic thinking and SCM-related competencies.

Based on data in Table 2, our observation of technology concepts and operation indicators reveals that the employees already have the ability to understand and implement the concept of digital technologies, ranging from software, hardware, network, and other advanced uses. However, some improvements are needed to increase employees' ability to perform *device troubleshooting*. Second, the digital citizenship indicator shows that the employees are able to participate in the digital society by using and accessing digital technologies in a responsible and ethical manner. This capability can be improved by increasing their knowledge of *digital ethics and cyberbullying*. Third, the digital content fluency indicator reflects the employees' ability to produce and manage digital content and generate creative ideas and innovations. This indicator is just slightly under the management expectation. As such, it needs to be improved in both *digital content creation and combination* elements. Fourth, we also found that digital communication, collaboration, and community connection competency that reflects the ability to communicate and collaborate through digital platforms in an online community is still lacking in the employees. Our data revealed that it is particularly low in terms of *involvement in an online community*. Finally, the data and information literacy indicators show that employees still have limited capacity to understand the processes and alternative strategies for data creation, collection, validation, and storage. It needs to be improved, particularly in terms of employees' information processing ability.

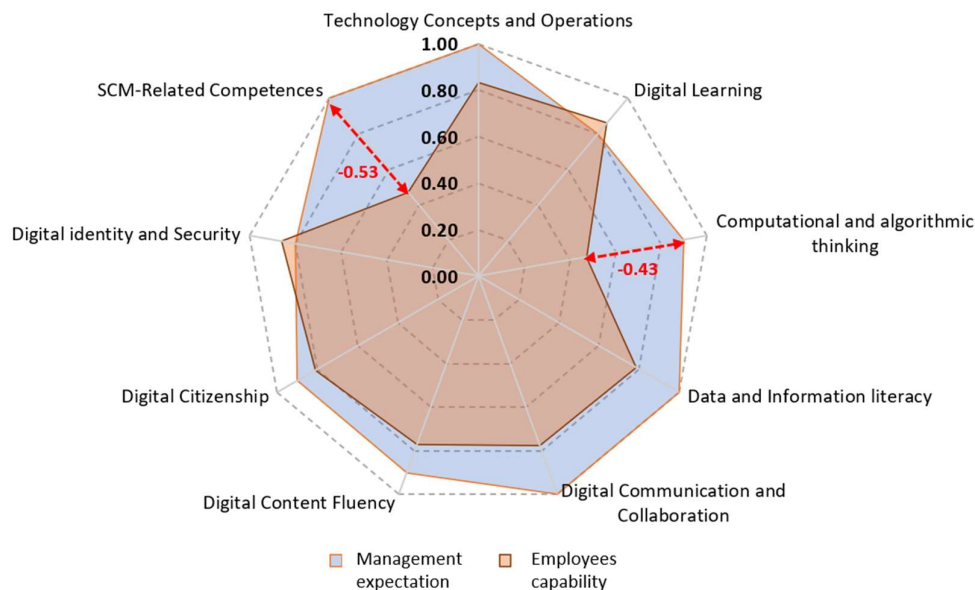


Figure 1 Gaps in Foundational and SCM-Related Digital Literacy

Employees are significantly lacking in computational and algorithmic thinking and SCM-related competences

Further analysis indicates that employees appear to have a very low ability to translate real problems into models or algorithms and a limited understanding of the usage and application of SCM-related technologies in day-to-day operation. However, the management has a very high expectation for those indicators, as highlighted in the following excerpts:

“Fresh graduates aspiring to work in this company are expected to have adequate logistics operation and computing skills” – Participant 1

“Digital competence for human resources in this company need to be improved..., particularly for SCM-related competencies” – Participant 2

Looking into our data in detail (Table 2), we found that all three elements of computational and algorithmic thinking (*i.e., tech translation and enablement, structured problem solving, and digital innovation*) score below 0.5 on a 0–1 point scale. Likewise, three elements in SCM-related competencies (*i.e., proficient use of SCM-related software, awareness of SCM issues, and data analytics in the SCM context*) score even below 0.4. These statistics indicate that employees' current level of digital literacy on those two indicators fulfils merely 40% of the management expectation. This is a significant

mismatch that needs to be addressed. Research has shown the criticality of those two competencies in increasing the effectiveness of the port operation. For example, inadequate computational and algorithmic thinking influences the ability of the port operator to maximise berth allocation planning, which eventually influences the berth throughput (Yıldırım et al. 2020). Similarly, SCM-related competencies become critical because ports have transformed into logistical platforms where various SCM-related activities occur (Thai 2012). Therefore, these specific gaps need to be closed.

4.3 Digital Literacy Roadmap

Figure 2 shows the proposed roadmap for enhancing foundational and SCM-related digital skills. First, we suggest the establishment of an in-house staff training program to improve the overall digital competencies of employees. This aligns with Kumar et al. (2017) that highlight the importance of continuous learning in the business environment to ensure business performance. The training program should focus on the two dimensions that show a significant gap (i.e., SCM-related competencies and computational and algorithmic thinking). The training should be provided to all employees working in various areas because the digitalisation of port operations covers commercial, operations, and human resources functions (Brunila et al. 2021). The training can be delivered in the form of workshops, seminars, technical guidance, and other formats (Valkanos and Fragoulis 2007). The training should also be carried out continuously to keep abreast with fast technological development.

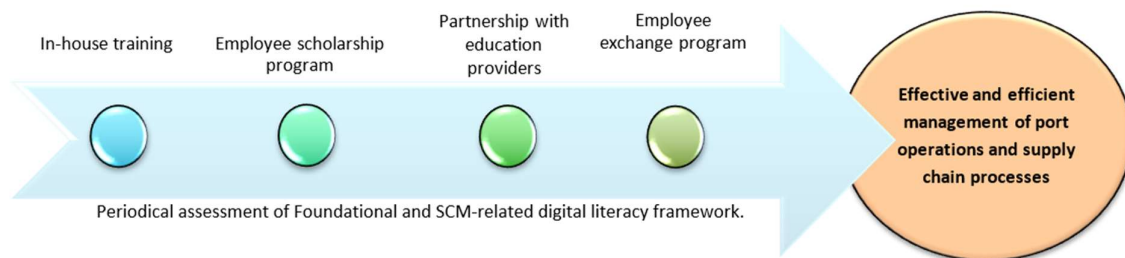


Figure 2 Digital Literacy Roadmap in the SCM Context

Similarly, management should also establish an employee scholarship program to facilitate employees to take further studies related to digital technologies in port operations. The literature has provided empirical evidence that company scholarship programs can attract better talent to join the workforce (Abeuova and Muratbekova-Touron 2019) and, at the same time, encourage employees to improve their digital literacy through education (Lee 2014). Following that, management should also strengthen strategic partnerships with education providers. An example of this strategic partnership is the establishment of an internship program for students in the local area that enable bidirectional knowledge transfer between the port operator and education providers (Parveen and Mirza 2012).

Furthermore, we also recommend that the port operator establish an employee exchange program that facilitates knowledge transfer among employees in different regions (Jehanzeb and Bashir 2013). Specific to our case study, the company could send several of their employees on a short-term assignment to work with the port operator in a western part of Indonesia that has undertaken a significant digitalisation process (Many 2018) to learn from previous experience and to enhance foundational digital literacy. Similarly, they could be assigned to work with the port operator in the central part of Indonesia that has a higher focus on SCM-related activities (Chin and Low 2010) to enhance SCM-related digital literacy. Finally, we recommend that the company assess the digital literacy of employees periodically using the proposed Digital Literacy Framework as an assessment tool to address potential issues and specific needs of employees in a timely manner.

5 Conclusion

The literature has indicated that insufficient digital literacy levels present a major inhibitor to port digitalisation. This condition is exacerbated in the context of port operations in developing countries, such as Indonesia, where digital literacy levels, in general, lag those of developed countries. Based on a case study with an Indonesian Port Corporation, our study has identified a gap between the digital literacy level expected by the port management and the digital literacy levels of the employees. This competency gap is primarily associated with the aspect of SCM-related competence and computational and algorithmic thinking. To address the digital skills gap identified in our study, we have identified five possible ways through which the port management could enhance their employees' digital literacy. They include the establishment of in-house training, scholarship program, strategic partnership, and

employee exchange program in order to increase the digital literacy level in the port operator environment. Importantly, the port operator could make use of the digital literacy assessment framework proposed in this study to monitor the result. These five actions are expected to close the current gap in foundational and SCM-related digital literacy, which has become a critical success factor in realising the economic benefits of supply chain and port operations.

This study contributes to the current understanding of the linkage between digital literacy and SCM operations. Specifically, we identify the level of digital literacy that should be possessed by stakeholders involved in the logistical activities to ensure the effectiveness of supply chain operations. Our study also enriches the current literature on digital literacy by providing an empirically validated framework for assessing digital literacy at the organisational level that considers foundational skills and SCM-related competencies. This study has demonstrated the usefulness of the framework in identifying digital skills gap of employees of Indonesian Port Corporation and devising appropriate strategies to address the gap.

This study has limitations in terms of the generalizability of its findings. The research was conducted in eastern Indonesia, so the findings cannot be generalised in the context of digital literacy of port operators in western and central Indonesia as port operations in those two regions are managed by different organisations. Therefore, future research is needed to enlarge the scope of analysis. In addition, future study is needed to understand other barriers that can contribute to the lack of digital literacy level. For example, potential barriers to digital literacy in developing countries may include inadequate ICT infrastructures that prevent young people from accessing advanced digital technologies (Kozma and Vota 2014). Revealing the dynamics of ICT infrastructures with the level of digital literacy will provide richer knowledge in developing strategies for increasing digital literacy at the organisational level.

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