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Critical Capabilities of Improving Supply Chain Resilience in Industrialized Construction in Hong Kong

Abstract

Purpose: Industrialized Construction (IC) has accelerated the technological advancements of construction Supply Chains (SCs) in Hong Kong (HK). However, the usually fragmented IC SCs often lead to friction and turbulence that retard their performance. Streamlining these workflows call for resilient SCs that can proactively overcome various vulnerabilities and avoid disruptions. Having identified Supply Chain Capabilities (SCC) as essential precursors to Supply Chain Resilience (SCR), this paper reports on a vital segment of a study on SCC for IC in HK that focused here on Critical SCC (CSCC). Specifically, this paper aims at identifying and probing the CSCC for improving SCR in IC in HK.

Design/methodology/approach: After drawing on the plentiful relevant literature, an empirical study using a questionnaire survey and interviews was conducted following the multi-stage methodological framework of this study. Relevant significance analysis of the collected data enabled the selection of CSCC. Next, factor analysis facilitated grouping them under nine underlying components.

Findings: The results reveal forty-one CSCC pertinent to achieve resilient SCs in IC in HK under critical capability components of resourcefulness, flexibility, capacity, adaptability, efficiency, financial strength, visibility, anticipation and dispersion.

Originality/value: It is expected that industry practitioners would benefit from prior knowledge of CSCC and their levels of criticalities, so as to prioritize integrating them suitably into SC processes, to develop value-enhanced-resilient SCs. Further, these findings lay the foundations for developing a powerful evaluation model to assess, then improve, SCR in IC in HK by mapping the identified CSCC with relevant critical vulnerabilities, based on study outcomes.

Keywords: Industrialized Construction (IC); Supply Chain Resilience (SCR); Supply Chain Capabilities (SCC); Critical Supply Chain Capabilities (CSCC)

Introduction

Industrialized Construction (IC) techniques have enabled hitherto unattained innovations in safe, clean, highly-efficient construction methods in the industry (Wang et al., 2020). IC techniques uplift conventional construction methods by injecting advantages of prefabrication (offsite mass production), including recent innovations such as Modular integrated Construction [MiC] (Ekanayake et al., 2020). More specifically, IC is enriched with improved quality, shortened delivery period, increased cost-effectiveness, reduced wastage, enhanced productivity and safety, and improved sustainability (Zhai et al., 2019). The higher the IC element, the lower the energy consumption; and indeed, IC is considered as an 'environment-protective' construction method (Wang et al., 2020). These significant contributions of IC to the construction industry, in turn, help boost the global economy, since the former is a key driver of the latter (Ahmed et al., 2020). Therefore, many countries have recently initiated promotional policies to uplift the implementation of IC. For instance, the Chinese government required that the percentage of IC in any individual project should be increased to 30% within ten years (Wang et al., 2020). Besides, IC fits well into the Hong Kong (HK) construction industry since HK is a compact city that faces the challenges of labour shortage, space constraints, escalating costs, ageing workforce (Zhai et al., 2019), limited access and site space, heavy traffic near the site, expensive land acquisition costs, floating population, and higher project capital and rental costs (Choi et al., 2019). Hence, HK construction has gained additional momentum fuelled by unique benefits from IC over the years, appreciating the leading efforts taken by the HK government (Choi et al., 2019).

However, IC Supply Chains (SCs) still face turbulence and disruptions due to SC fragmentation, poor traceability and lack of real-time information (Wang et al., 2020). These disruptions warrant particular improvements to SC capacities that help to deal with common disruptions. In this regard, developing Supply Chain Resilience (SCR) helps in effective withstanding of these disruptions (Ekanayake et al., 2019). SCR improves the adaptive capability of SCs to reduce the probability of disruptions by vulnerabilities, to resist the spread of any adverse impacts, and to respond and recover immediately after a disruption to restore operations to a robust state (Kamalahmadi and Parast, 2016). Thus, SCR imperatives ensure high performance and customer value (Chowdhury et al., 2019) by reducing the additional cost implications, delays and safety hazards resulting from SC vulnerabilities. SCR only can be improved by improving the appropriate Supply Chain Capabilities (SCC) (Pettit et al., 2013). Therefore, it is essential to identify the appropriate SCC, especially the Critical SCC (CSCC) and to know their relative levels of importance in the IC SCs. However, there is no known previous attempt to determine CSCC in IC and to thereby improve SCR, despite more, extensive research being needed for the specific development of IC supply chains.

Given the above background, this study aims at identifying and probing the CSCC for improving SCR in IC in HK, from the viewpoint of industry experts. Based on the CSCC findings of this study, industry practitioners will be well informed on resilient, value-enhanced IC supply chain processes based on significant knowledge creation in IC in HK. Further, identifying the levels of importance of these CSCC clears pathways to incorporate them appropriately in IC supply chains. These identified and calibrated CSCC will also be integrated into an SCR model developed in a future research study by proposing directions and strategies to boost SCR in IC in HK. The forthcoming sections respectively explicate the systematic literature review conducted to identify the SCC, details of the empirical study conducted, research methods adopted, data analysis and results, followed by a focused discussion and the conclusions drawn from this study.

Background

SCC are the building blocks for improving SC strategy, operational excellence and healthy clients' relationships (Morash, 2001). They act as counter-balancers to counteract SC disruptions arising from so-called SC vulnerabilities (SCV) (Zavala et al., 2018). Hence, SCC are associated with the ability to anticipate and overcome SC disruptions (Pettit, 2013) which disturb the typical construction process (Ekanayake et al., 2019). Besides, SCC has, therefore, become a topic which drew increasing research interest in recent years (Cui, 2018; Gölgeci and Kuivalainen, 2020).

In previous attempts, Christopher and Peck (2004) proposed transhipping, dual sourcing and visibility as SCC. Further, robustness, agility, leanness and flexibility were also identified as the SCC (Purvis et al., 2016). SCC have two dimensions, namely, proactive and reactive (Wieland and Wallenburg, 2013). Reactive capabilities enable SCs to respond rapidly to changes by 'adapting its initial stable configuration' while proactive capacities strengthen withstanding abilities of the SCs (Wieland and Wallenburg, 2013). An SCC assessment tool with 13 factors developed by Pettit et al. (2013) was intended for manufacturing and service firms. Findings of Chowdhury and Quaddus (2015) on SCC were specific to the Bangladesh garment industry. As the first study related to the construction industry, Zainal and Ingirige (2018) offered 12 capability factors [flexibility, efficiency, capacity, visibility, adaptability, anticipation, recovery, dispersion, collaboration, market position, security and financial strength] to improve SCR in Malaysian public projects. Since IC is developed by incorporating advances in offsite manufacturing practices, IC supply chains are more complicated than the traditional construction practices and include SC phases of manufacturing-factory, logistics and onsite assembly (Ekanayake et al., 2019). Also, the SC configuration and the level of vulnerability differ across jurisdictions. Therefore, a jurisdiction (HK) specific separate study for IC was needed to determine the SCC to withstand associated SC disruptions in IC. In this regard, Ekanayake et al. (2020) conducted a systematic review of literature through metaanalysis and identified 58 SCC as appropriate to IC. However, the study findings were not verified through empirical justifications and did not probe variations in the levels of criticality of these capabilities.

CSCC improving SCR in IC

Given the above background and the importance of SCR implications to IC, this follow-up study was motivated to identify CSCC associated with IC in HK. Critical factors could profoundly influence developing resilient SCs in IC in HK. These CSCC are specific to the industries (Pettit et al., 2013) and can significantly improve SC performance. However, research to date has not yet identified CSCC in IC by assessing levels of criticalities in an industry-specific context. In addressing this lacuna, this study pre-tested and then tested through empirical research, the identified SCC from the precursor study of Ekanayake et al. (2020) to determine the CSCC, their appropriate groupings, and their levels of criticality pertaining to IC in HK. Being the overwhelming contribution of this study, these findings should attract the attention of industry professionals in HK to focus on 'defending' critical SC vulnerabilities through suitably reinforced SCs in IC. Ultimately, such resilient and performance-enhanced construction SCs could help boost the global economy as a key economic driver, contributing to a more resilient and sustainable economy.

Research Methodology

Identification of CSCC improving SCR in IC in HK

Basing the research approach on the positivism philosophy, a deductive research approach was primarily adopted in this study. However, the use of interpretivism philosophy was also found useful and important, in seeking and providing industry-based justifications for the quantitative results. Fig.2 visually summarizes the research methods used and their flow in this study.

[Insert Fig.2. here]

Accordingly, a set of 58 SCC for improving SCR in IC was firstly determined from a review study by Ekanayake et al. (2020). Then, the factors were tested for significance, comprehensiveness and applicability to HK IC through a preliminary study. In this preliminary study, four professors who are knowledgeable in this research domain were involved. These professors were co-opted into this process since they had both academic and industry experience of more than 20 years each, and hence, they were the experts relevant to this study. After careful consideration of all factors, the participants recommended removing 'brand equity of the organizations' as they thought this SCC is not highly influential in the construction industry since IC is practised in the industry by the reputed construction organizations which had already developed significant brand equity within the industry. Although the professors did not 'highly agree' with the SCC of 'conducting parallel processes instead of series processes', they suggested retaining this factor for reconsideration, after the primary data collection. Hence, 57 SCC were confirmed after the preliminary study. Table 1 presents the list of selected SCC with their respective references.

[Insert Table 1 here]

Data Collection

This study, thereafter, employed a mixed-method data collection approach combining a questionnaire survey with semi-structured interviews as an integrated strategy to extract respondents' personal opinions and experience on SCC. This triangulation approach is more beneficial than a purely qualitative or exclusively quantitative research approach (Creswell, 2014). A questionnaire was developed by including the confirmed 57 SCC factors. Section I of the questionnaire solicited the background information of the respondents, which is advantageous in assessing the reliability of the survey respondents. A five-point Likert scale was adopted, and the respondents were requested to grade the identified SCC from 1 (not important) to 5 (extremely important) in the second section of the questionnaire. This scale was adopted due to its relative brevity (Adabre and Chan, 2019). Additional rows were also provided to the respondents to add any known SCC that were not captured in the preliminary study. A semi-structured interview guideline was also created to capture subjective information related to the identified capabilities. A pilot test was then conducted (using five experts; two industry experts and three academics with industry experience in IC in HK) to determine the relevance and the understandability of the questions in the questionnaire and the interview guideline. The data collection tools were ratified and refined based on the expert comments, after which the data collection proceeded.

The targeted respondents of this study were industry experts in both the public and private sector involved in IC in HK. Fig.1 depicts the profile of the respondents/interviewees who participated in this study. These respondents were at managerial level or above with experience in the HK IC process, as in Fig.1. These experts were selected for this study considering their vast knowledge and experience in IC in HK and their ability to convey their knowledge in English. A purposive sampling technique was adopted in selecting these respondents as followed by Owusu and Chan (2018). These experts were contacted by exploring their business profiles, through the industry-based contacts, and attending seminars related to IC in HK. Snowball sampling technique was further used to widen the 'respondent catchment area' for this study. All these respondents were contacted face-to-face or using online interviews.

[Insert Fig.1. here]

At the interviews, first, a brief description of the study was conveyed, then respondents/interviewees were asked to complete the questionnaire, after which the respondents were interviewed using the semi-structured interview guideline (lasting for 40-150 mins). Seventy-six valid responses were finally collected and deemed as appropriate for the analysis since a sample size of 30 is representative of any group (Ott and Longnecker, 2015) and adequate to develop significant conclusions in a subject area of this nature (Owusu and Chan, 2018). Besides, the 76 response rate is higher than the response rates obtained in some of the previous survey-based construction management studies (Adabre and Chan, 2019, Owusu and Chan, 2018, Darko and Chan, 2018).

Data Analysis and Results

The gathered data were then subjected to factor analysis to generate useful findings and results. This paper mainly presents quantitative data analysis results. The collected qualitative data were used to provide empirical justifications to the quantitative findings. Further, this study details the first empirical findings related to CSCC for improving SCR in IC in HK.

The Statistical Package for Social Sciences (SPSS), IBM-SPSS-25, was used to analyze the questionnaire findings. Descriptive means with normalization, reliability analysis, normality test, and factor analysis were utilized in data analysis. Data normalization analysis was conducted prior to the SPSS analysis to determine the critical factors among the set of identified factors following the studies of Osei-Kyei and Chan (2017) and Adabre and Chan (2019). Therefore, the mean-scores of all the SCC factors were computed and then, their respective normalized values were calculated. Factor criticality was determined based on the normalization values. The factors with normalized value > 0.50 were counted as critical factors for further analysis (Osei-Kyei and Chan, 2017; Adabre and Chan, 2019).

Mean score ranking and data normalization

Statistical Mean (M), Standard Deviation (SD), and the normalization (N) values for each SCC factor were calculated and presented in Table 1. Where some factors received a similar M value, the factors which received the least SD were ranked first. Based on the normalization values (N>0.5), 42 SCC were identified as the CSCC and considered them in the factor analysis.

Internal reliability and data normality test

The data were tested for their appropriateness and reliability using Cronbach's alpha since it is mandatory for the justification of the results (Adabre and Chan, 2019). Besides, Cronbach's alpha test tool is commonly used, more flexible and provides sound estimates (Brown, 2002). Cronbach's alpha value varies from 0 to 1, where 0 represents 'not reliable,' and 1 signifies 'highly reliable' (Tavakol and Dennick, 2011). However, the acceptable value is between 0.70-0.95, and the effective limit is between 0.70-0.90 (Tavakol and Dennick, 2011). In this study, the alpha coefficient of 0.968 shows that the 42 SCC factors are internally reliable or consistent (Tavakol and Dennick, 2011). A data normality test was also conducted using the Shapiro-Wilk test to determine the nature of the type of data distribution (Owusu and Chan, 2018) because the Shapiro-Wilk test is 'the most powerful normality test' (Razali and Wah, 2011). The null hypothesis of 'the data is normally distributed' was rejected, leading to a conclusion that the data in this study is non-normally distributed since the test value is less than the stipulated p-value, using a common significance level of 0.05 (Table 1).

Factor analysis

Factor analysis is a data reduction statistical technique which categorizes a set of variables into a lower number of more significant variable components using factor points of responses (Pallant and Manual, 2010). This study, therefore, deployed the factor analysis technique to determine the underlying categorized variables that represent the CSCC improving SCR in IC in HK. Subsequently, the Kaiser-Meyer-Olkin test (KMO) and Bartlett's test of sphericity were conducted. KMO measures the sampling adequacy of a data set (Dziuban and Shirkey, 1974) whereas Bartlett's test of sphericity checks for the variance homogeneity (Tobias and Carlson, 1969). KMO ranges between 0-1, where 0 indicates an inappropriate data set and 1 indicates a perfectly appropriate data set for factor analysis (Dziuban and Shirkey, 1974). As the value obtained in this study is .810 (which is above the required minimum of 0.500), the data can be considered as appropriate for factor analysis. The population correlation matrix was not an identity matrix since the sphericity test statistic was relatively large (3370.583), with a corresponding lower significance level ($p<0.05$) (which is 0.000) (Tobias and Carlson, 1969). These statistical results are presented in detail in Table 2.

[Insert Table 2 here]

Then, the study proceeded with factor analysis. First, factor extraction was conducted using the principal component analysis and the variables with the eigenvalues less than one were eliminated (Chan et al., 2018). Therefore, only 42 CSCC with eigenvalues above 1 remained. The varimax rotation was done for these 42 CSCC, which generated nine underlying components, explaining 79.77% of the total variance (Table 2). Only 41 CSCC were successfully loaded into the nine underlying components since their factor loadings were above 0.40, and they were considered as significant factors (Li et al., 2011). 'Backup utilities (C13)' was excluded from the list since the factor loading was below 0.4. According to the respondents, utility disruptions are infrequent in IC in HK, and the SCs are not susceptible to these disruptions. Hence, they did not perceive any need for backup utility sources which may also consume cost and time. Table 2 summarizes the variables and respective factor loadings along with the developed nine components. Component naming was done based on the common themes that were underlying the variables. If there was no clear underlying common theme; naming was done based on the variables with higher factor loadings (Owusu and Chan, 2018, Zhang et al., 2016).

Discussion

Component 1-Resourcefulness (RES)

Component 1 consists of seven underlying factors and, all these factors facilitate a collaborative, secure and resourceful approach to enhance SCR, hence named as 'resourcefulness'. This component manifests the highest percentage of variance, which is 44% with the highest variable content. Personal security is the highest loaded factor within the category-(0.768), highlighting the dire need for improved safety at the site. Although IC facilitates improved safety (Wong et al., 2003), personal security is essential during the installation of prefabricated components as there are fracture and fall-related hazards (Y. Li et al., 2011). The experts highlighted that, if there is a severe safety disruption, the sites are closed until all the safety inquiries are completed, posing other problems from disruptions. All projects which are under the public housing authority need to undergo quarterly safety audits, where any failures may trigger blacklisting of the contractors from future projects, thereby safeguarding safety at IC sites. Collaborative forecasting, decision making, and information exchange are vital (Ekanayake et al., 2019) since these facilitate effective and successful decision making. That is why these two factors received relatively high factor loadings of 0.702 and 0.656. To address existing shortfalls in these areas, Y. Li et al. (2011) proposed virtual prototyping and Zhong et al. (2017) introduced an Internet of Things (IoT) enabled BIM platform in their studies to improve the collaborative data interoperability in the IC supply chains. Cybersecurity is another main challenge faced (Ghaffarianhoseini et al., 2017) and it is imperative to provide appropriate cybersecurity to the SC information, data sharing and use to avoid unauthorized data access and copyright infringement even in IC supply chains. Obtaining more competitive price from suppliers reduces the price risks associated with SCs (Lim et al., 2011). Having multiple-supplier sources enable consistent production of IC since most of the prefabricated units are outsourced or imported from Mainland China to HK. This outsourcing can lead to acute logistics disruptions and cause onsite assembly delays as experienced already. Hence, having supplier backups, including transportation supplier backups, are very important. Maintaining adequate buffer time between SC operations reduces the vulnerabilities due to tardiness in site deliveries (Zhai et al., 2018). Even in HK, the IC SCs have faced delays due to tardy delivery of prefabricated components, so maintaining an adequate buffer time was helpful (Ekanayake et al., 2019).

Component 2- Flexibility (FLE)

FLE component exhibit 7.4% of the variance, including six factors. These FLE variables reflect the ability of quicker resource mobilization in response to a disruption. As the highest loaded factor, vertical integration is beneficial since there are vulnerabilities due to outsourcing. However, outsourcing facilitates increased sustainability in the SCs because the third-party logistics providers practice improved resource utilization and efficient processes. As most of the contractors do not have their in-house prefabrication plants, they are denied higher profit level under the decision of self-manufacturing (Han et al., 2017), necessitating vertical integration of the SC manufacture and assembly. For example, postponement of the production of prefabricated units could be required if there are onsite disruptions such as tower crane breakdowns and safety hazards (Ekanayake et al., 2019). Besides, most of the construction sites in HK are very congested and early, or excess delivery of materials can cause intolerable queuing problems. These demand flexible production of prefabricated components where the production postponement is required. Since IC supply chains are highly susceptible to logistics disruptions (Wang et al., 2018) due to the transportation of imported oversized/overweight prefabricated units, the availability of alternative transportation channels are encouraged to avoid delays in IC in HK (Ekanayake et al., 2019) [with this ranking as the tenth critical of the SCC with the mean value of 4.18]. In this circumstance, having flexible agreements with transportation suppliers is practised by HK companies. As the latest initiative, MiC is introduced as it offers more opportunities to improve project performance, and the industry is appreciating the associated benefits (Choi et al., 2019). Also, modular designs enable multiple/repeat uses of the materials and equipment, including metal formwork systems. Besides, appropriate production planning by utilizing optimum outsourcing quantities add more value to modular product design (Hsu et al., 2017). By identifying the need for risk-sharing/pooling, even IC utilizes risk-sharing techniques to help withstand SCV. For instance, sharing inventory holding costs (Zhai et al., 2018) can help in this respect. Also, the experts identified the necessity of private-public collaboration as a proper risk-sharing mechanism in IC supply chains, where joint ventures or partnerships are not too familiar.

Component 3- Capacity (CAP)

CAP as the 3rd component evinces the 3rd highest mean score, signifying the importance of the component towards improving SCR. Variables in this component enable the availability of SC resources for continuous operation. Although having backup equipment is beneficial in other SCs, in IC, the primary equipment used are cranes. Hence, it is vital to have reliable backup maintenance agreements with the equipment suppliers or the maintenance companies as practised in HK IC projects. Since tower crane and material hoists breakdowns are common in IC in HK, 'redundancy' of the SC to bypass any such disruptions is required (Ekanayake et al., 2019). Redundancy increases SCR by facilitating quick recovery without leading to system failure (Sheffi and Rice Jr, 2005). Redundancy depends upon the organizational capacities to manage uninterrupted workflow during disruption, and it should stop aggregating the damages and losses. According to the experts, it is still questionable that the existing capacity of many firms can provide redundancies to overcome disruption and maintain continuity in IC SCs in HK. This alerts practitioners to the need for capacity improvements. Although traditional risk management is adopted as a crisis mitigation technique, it does not enable adequate protection over all possible threats (Van Der Vegt et al., 2015), positioning SCR as improved crisis management technique (Zavala et al., 2018). Irizarry et al. (2013) also proposed to deploy GIS and digital building information technologies in IC supply chains to enhance emergency response management, which can be considered as another initiative. Having a capable professional team to handle disruptions and effective communication strategy during a disruption is also very important for a speedy recovery (Zainal and Ingirige, 2018). This should explain why the factor of having a capable professional team to handle disruptions 'scored' the fifth-highest mean value of 4.24. Also, having an effective communication strategy was ranked as the eighth critical of the SCC. A few reputed construction companies have integrated the entire production system with BIM models by improving communication between the project professionals and enhancing their accountability in case of IC failures in HK.

Component 4-Adaptability (ADA)

ADA includes five CSCC which provides SCs with an ability to adapt in response to SCV with a variance percentage of 5.28. Having a strong reputation for the quality of the construction output and maintaining close and healthy relationships with clients is highly beneficial to recover from a dip in the market position of an organization, identifying the ninth critical SCC factor with 4.17 mean score. HK public clients conduct quality audits quarterly on IC contractors, and their future work eligibility is decided based on their past performance. With the increase of market size, even the profit levels may increase (Han et al., 2017) and improve the resilience capabilities in IC. Further, lead time reduction including production lead time hedging, operational lead time hedging and transportation lead-time hedging are also suggested as effective ways to raise adaptability in IC (Zhai and Huang, 2017, Zhai et al., 2017, Zhai et al., 2018). This avoids unnecessary storage throughout the entire SC process. Faster delivery of construction output also improves the resilience capacity, which is manifested in MiC methods. Therefore, IC SCs should encourage adopting MiC for improved adaptability of SCs in the context of the HK construction industry. Fast re-routing of requirements is another of the CSCC (Peck, 2005) which enhances the adaptability of an SC by provoking steady and immediate reinstatement of the processes after a disruption. Therefore, capable, resourceful and flexible SCs are necessitated in this context, highlighting the useful integration of SCC categories.

Component 5- Efficiency (EFF)

Efficiency is the CSCC component with the highest mean score value; 4.187, highlighting its component significance. This component reflects the ability to produce construction outputs with minimum resources and without contributing to wasteful practices. Mean scores of all the factors of EFF are higher than 4.000, hence, vital for improved SCR in IC in HK. Failures can occur at any phase of IC supply chains beginning from manufacture to assembly (Li et al., 2018a). Also, there can be failures in the product. In IC, product failures happen due to tolerance issues of the prefabricated components (Ekanayake et al., 2019).

Further, these failures and inadequate information sharing cause variations or rework in IC; hence, it is vital to utilize failure prevention measures considering that failure prevention has received seventh-highest mean score. The technological breakdown is another reason for variations or rework (Luo et al., 2018). Therefore, necessary precautions should be taken in advance, including with SC collaboration and effective information sharing (Wu et al., 2014) to prevent product failures, and SC variations/rework. Besides, the experts have ranked - taking preventative measures to avoid variations and rework - as the fourth critical capability measure. IC in HK is affected by high costs and low productivity of labour (Ekanayake et al., 2019). That is why the prefabrication factories are in Mainland China, to benefit from lower labour cost. If higher labour productivity can be achieved in HK, the vulnerabilities stemming from importation and logistics may be minimized.

It is proven that IC benefits from cost savings through the waste reduction in the project SCs (Jaillon et al., 2009). However, non-value-added activities (waste) are still possible with the inadequate tolerance and assembly issues, logistics failures and manufacture failures (Ekanayake et al., 2019), hence, highlighting the need for SCR through waste elimination and lean SCs (Yu et al., 2013). As suggested by Peck (2005), it is beneficial for any organization to deploy lessons learnt to manage SCs efficiently as the sixth critical capability; and IC in HK is not an exception. According to the current practice, although the project appraisal or analysis reports were hard to observe, the experts suggested the importance of having records of the lessons learnt for future potentials. In contrast, some of the practitioners considered maintaining these records as wasteful activities due to the temporary multi-organizational structure of the construction projects.

Component 6-Financial Strength (FIS)

Having good financial strength in an organization is essential to improve operational performance (Yuan et al., 2018) in a competitive industry such as construction. Therefore, the FIS component was unsurprisingly ranked with the second highest mean score; 4.175. According to the findings of Han et al. (2017), higher profit levels of all IC supply chains are feasible with increased market size and any self-manufacturing decisions (portfolio diversification and vertical integration). Besides, it is mandatory to maintain healthy cash flows, including financial reserves, to pay prefabricated components manufacturers on time (Kadir et al., 2005) and to withstand all the financial vulnerabilities associated with SCs (Ekanayake et al., 2019).

Given that the importance of having substantial financial reserves/funds, the factor was ranked as the third critical capability factor with 4.35 mean score. Indeed, IC supply chains need insurance coverage for the items in stores, and offsite during the logistics as a mechanism for timely and assured delivery of IC outputs while resisting disturbances (Fateh and Mohammad, 2017). Also, having insurance and contingency allocations is essential in IC as a safeguard to bear the uncertainties and losses since the construction sequence is standardized and fixed (Ekanayake et al., 2019). That is why the experts ranked having adequate insurance coverage as the second critical SCC with the mean value of 4.37. Although IC projects in HK are usually financially feasible, the respondents highlighted the importance of these FIS related CSCC factors for resilient SCs.

Component 7-Visibility (VIS)

VIS refers to having sound knowledge of ongoing SC operations and the environment. This component includes three factors, accounting for 4.036 mean score and 1.297 variance percentage. According to the findings of Li et al. (2019), there is a gap of efficiency and collaboration in decisionmaking systems in IC since the relevant information is stored and handled in diverse systems of various stakeholders, who are geographically isolated. Collaboration is identified as the soft aspect of SC management, which enhances team learning and team performance in construction SCs (Koolwijk et al., 2018). A Building Information Modeling (BIM) integrated IC was proposed by the above-cited authors to improve the SC visibility. An Internet of Things (IoT) enabled BIM platform is another initiative to enhance real-time data visibility and traceability of IC supply chains in HK (Li et al., 2018b). BIM and virtual prototyping technologies provide robust avenues for different SC stakeholders to improve their daily operations, collaboration, decision making, and supervision throughout the construction. Also, RFID and barcode detecting methods add to SC visibility through real-time data capture, enhanced speed and accuracy of data entry (Y Li et al., 2011). Also, BIM and Geo-Information Systems integrated methods improve logistical visibility of IC supply chains (Irizarry et al., 2013).

Component 8-Anticipation (ANT)

Anticipation as the eighth component includes five CSCC measures which provide the ability to detect potential future SCV. Quality control with the highest mean score: 4.413, is also included in this component. This is very important in IC to avoid tolerance issues. Therefore, some contractors appoint special quality checkers even at the manufacturing factories for better quality control (Ekanayake et al., 2019). The contractors who have their manufacturing plants, maintain quality through BIM-enabled systems as a novel initiative. IoT, BIM, RFID and barcode enabled tools provide not only real-time visibility but also enable promising traceability in the SC process (Li et al., 2018b). These developments are vital in avoiding transport disruptions, excess storage demands, and prefabricated component queues in HK. BIM integrated project management tools can help to trigger early warning signals before any disruptions, as model simulations are possible with the techniques. Intensive training is essential as the assembly of prefab components require skilled labour (Ekanayake et al., 2019), especially since they are related to risky operations (Fard et al., 2017). Developing and employing innovative technologies improve the anticipation and also eases adaptation during a disruption. Innovative tools such as BIM and other IoT based techniques and tools have already been adopted in IC in HK, thereby reaping associated benefits and calling for new initiatives to enhance SC performance.

Component 9-Dispersion (DIS)

The last component, DIS, includes just one factor, albeit with a significant (mean score=4.067) of the CSCC, namely, distributed decision making. This resembles the decentralization of decisionmaking power, which is substantial during onsite problem-solving. Besides, robust decision making is asserted as essential even in the advanced manufacturing of prefab components (Arashpour et al., 2017). Also, quick but sound decisionmaking is required in the materials flow control process to reach a balance between onsite buffers of components and just-in-time deliveries (Bataglin et al., 2017). Determining transportation batch sizes is another critical decision that should be taken for controlling the flow of prefabricated components and synchronizing these timings in both the prefabrication plant and assembly site (Bataglin et al., 2017). Therefore, these key decisions should be collaboratively taken by the relevant SC stakeholders involved in the flow of the prefabricated components (Zhang and Yu, 2020). Under these circumstances, distributed decision making is identified as a CSCC to enhance the ability to withstand SCV successfully. BIM is, therefore, introduced as a supplement to the SCR through decentralized decisionmaking (Bataglin et al., 2017).

[Insert Fig.3. here]

Fig.3 presents an overall summary of CSCC with the level of criticality to IC in HK derived from relevant significance analysis. The first ranking factor is 'quality control' (C35) with an M value of 4.413. IC supply chains in HK are significantly susceptible to the tolerance issues allied with quality control. Hence, monitoring quality is essential to improve SCR. This could be why the respondents have ranked this SCC as the most critical factor. Alternative innovative technology development (C25) received the least score since the HK construction industry may be considered as more innovative and inject new technological advances into construction processes.

Research Limitations

It is necessary to note some limitations that constrained the study. Although the sample size (76) used in this study is not unduly small, this study pursued data triangulation by conducting both the questionnaire survey and the interviews to boost the reliability of the results and interpretation. Subsequent studies may improve the response rate for even better generalization of the results. However, the associated vulnerabilities, capabilities and their levels of criticality would necessarily differ, although some interesting core commonalities may hopefully emerge. Hence, country-specific case-studies would enable more applicable and robust results while helping to verify the findings generated in this study.

Further, the commercial relationships between supply chain partners/members could be investigated since a deep understanding of these and the underlying economic exchange and transactional profiles may be needed before addressing specific vulnerabilities arising from typical (e.g. skewed/ asymmetric, even seemingly unfairly weighted) commercial relationships that have developed from standardized contracts and/or standard practices. Despite these limitations, the useful specific findings from the current research are seen to contribute substantially to the HK construction industry and relevant theory, by clearly identifying and highlighting important CSCC, along with their levels of criticality.

Conclusions

IC has attracted the heightened interest of stakeholders recently, especially in the HK construction industry, highlighting its inherent technological advancements and potential to address the ‘new normal’ imperatives to further reduce on-site operations i.e. in less controlled environments. However, IC is not immune from commonly encountered industry turbulence which necessitates closer attention to SCR, but the literature remains silent on important SCC initiatives in this regard. In response, empirical research was conducted, leading to 76 questionnaire and interview responses from industry experts and experienced practitioners in IC projects in HK to determine CSCC as the most influential factors in achieving SCR. The results revealed 41 CSCC as appropriate and useful to the IC SCs, while 'quality control' was identified as the most influential factor. Nine underlying component groups of these CSCC, namely, resourcefulness, flexibility, capacity, adaptability, efficiency, financial strength, visibility, anticipation and dispersion, were developed as resulted from the factor analysis. Although the component 'flexibility' received the highest variance percentage, 'efficiency' was the component with the highest mean score. This provides examples of which group components need more attention for specific types of improvement, for improving SCR in IC in HK. The contribution of this research can be taken as twofold. On the one hand, it provides an in-depth understanding of CSCC related to IC in HK, and on the other hand, it assesses the relative levels of the criticality of the grouped CSCC.

All identified nine components could be focused upon, for improving practice as specific components under common themes and influence different stages of SC processes. These findings, therefore, draw stakeholders' attention to 'defending' related SCV through CSCC and developing value-enhanced, resilient SCs in IC in HK. Expanding the horizons of the parent study and looking beyond the boundaries of this paper, an SCR evaluation model could be established by integrating the previous study results of critical SCV and these study findings of CSCC. Moreover, significant attention should be paid on the CSCC, for overcoming SCV, boosting IC productivity in particular, and thereby catalyzing general advances in ameliorating the performance conundrum faced by the HK construction industry.

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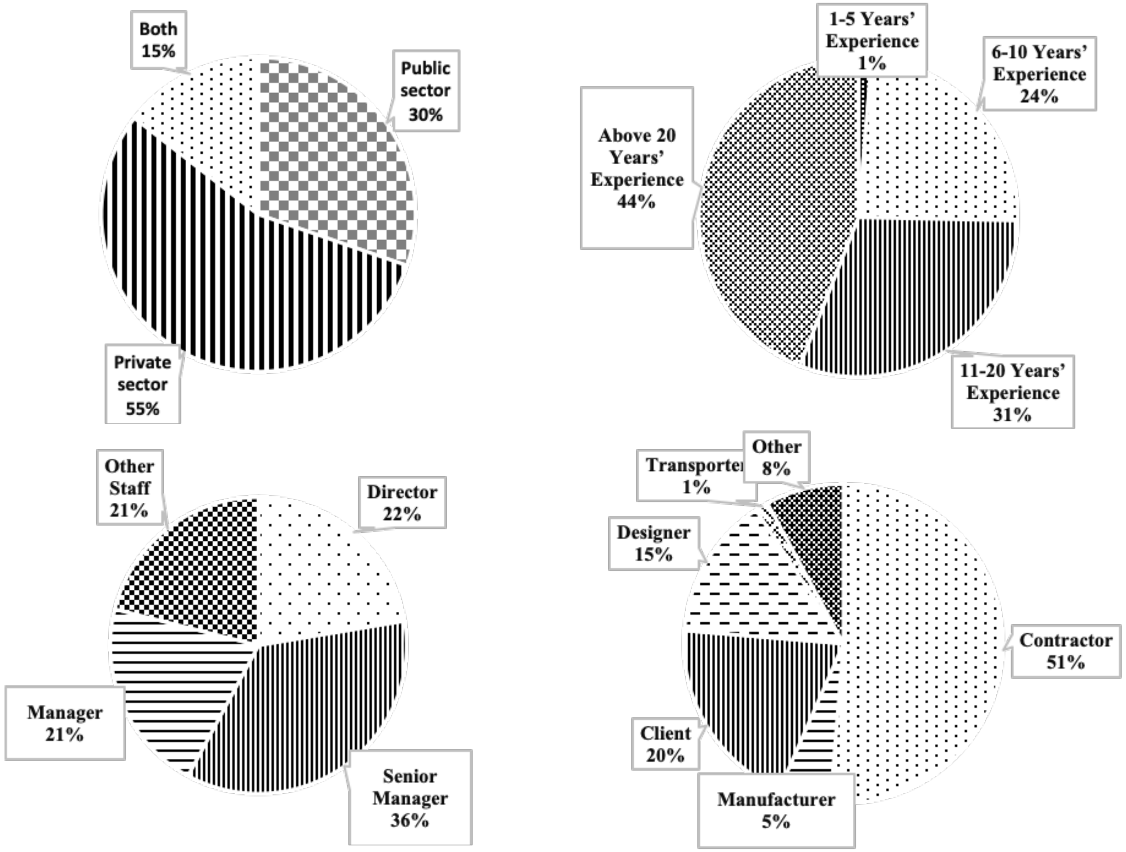
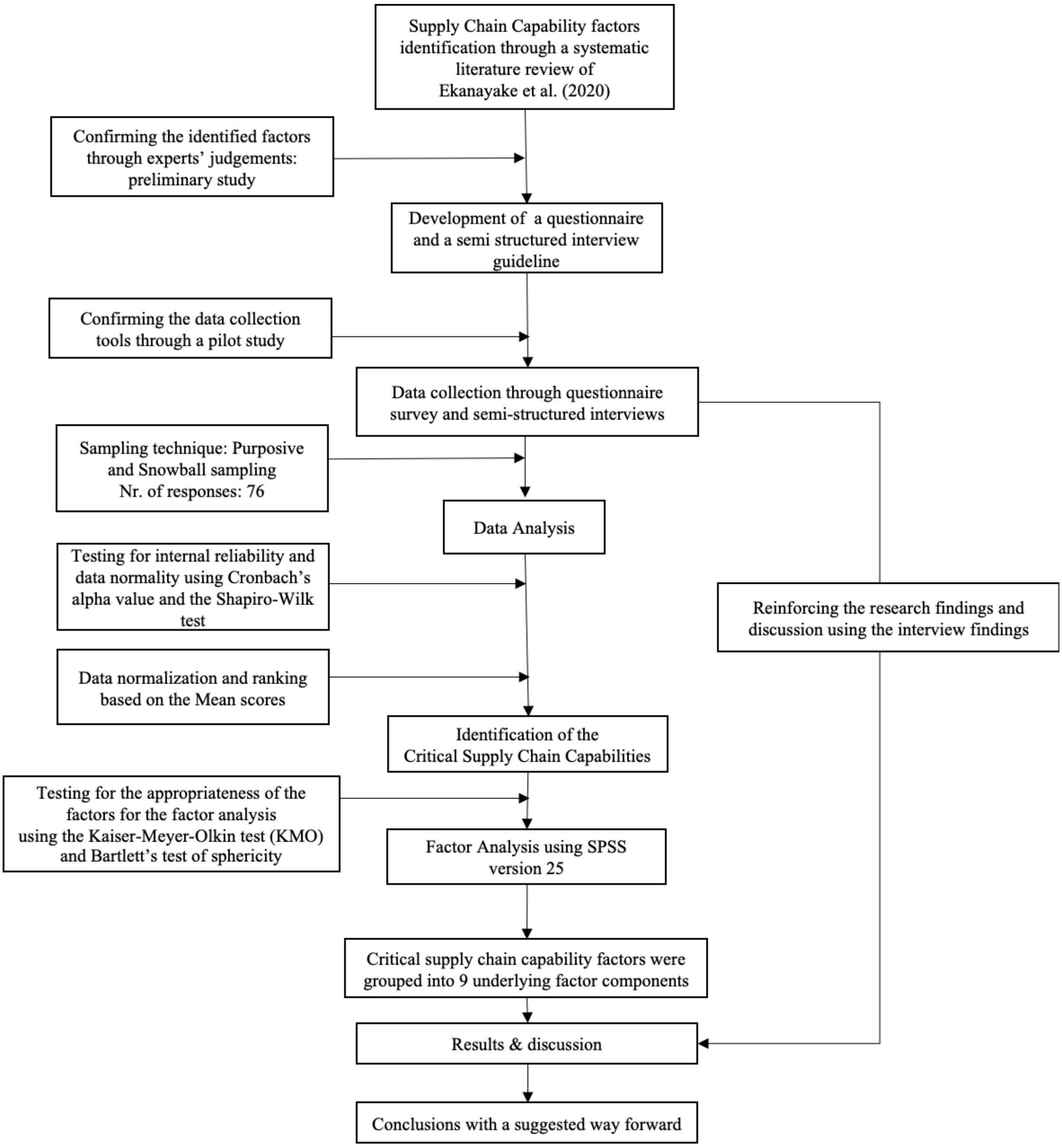


Category	Number of respondents	Relative frequency
Public Sector	23	30.3
Private Sector	42	55.3
Both	11	14.4
Total	76	100.0
Contractor	39	51.3
Manufacturer	4	5.3
Client	15	19.7
Designer	11	14.5
Transporter	1	1.3
Other	6	7.9
Total	76	100.0
1-5 Years' Experience	1	1.3
6-10 Years' Experience	18	23.7
11-20 Years' Experience	23	30.3
Above 20 Years' Experience	33	44.7
Total	76	100.0
Director	17	22.3
Senior Manager	27	35.5
Manager	16	21.1
Other Staff	16	21.1
Total	76	100.0

Fig. 1. Profile of the respondents.


Supply Chain Capability factors identification through a systematic literature review of Ekanayake et al. (2020)
Confirming the identified factors through experts' judgements: preliminary study
Development of a questionnaire and a semi structured interview guideline
Confirming the data collection tools through a pilot study
Data collection through questionnaire survey and semi-structured interviews
Sampling technique: Purposive and Snowball sampling Nr. of responses: 76
Data Analysis
Testing for internal reliability and data normality using Cronbach's alpha value and the Shapiro-Wilk test
Data normalization and ranking based on the Mean scores
Reinforcing the research findings and discussion using the interview findings
Identification of the Critical Supply Chain Capabilities
Testing for the appropriateness of the factors for the factor analysis using the Kaiser-Meyer-Olkin test (KMO) and Bartlett's test of sphericity
Factor Analysis using SPSS version 25
Critical supply chain capability factors were grouped into 9 underlying factor components
Results & discussion
Conclusions with a suggested way forward

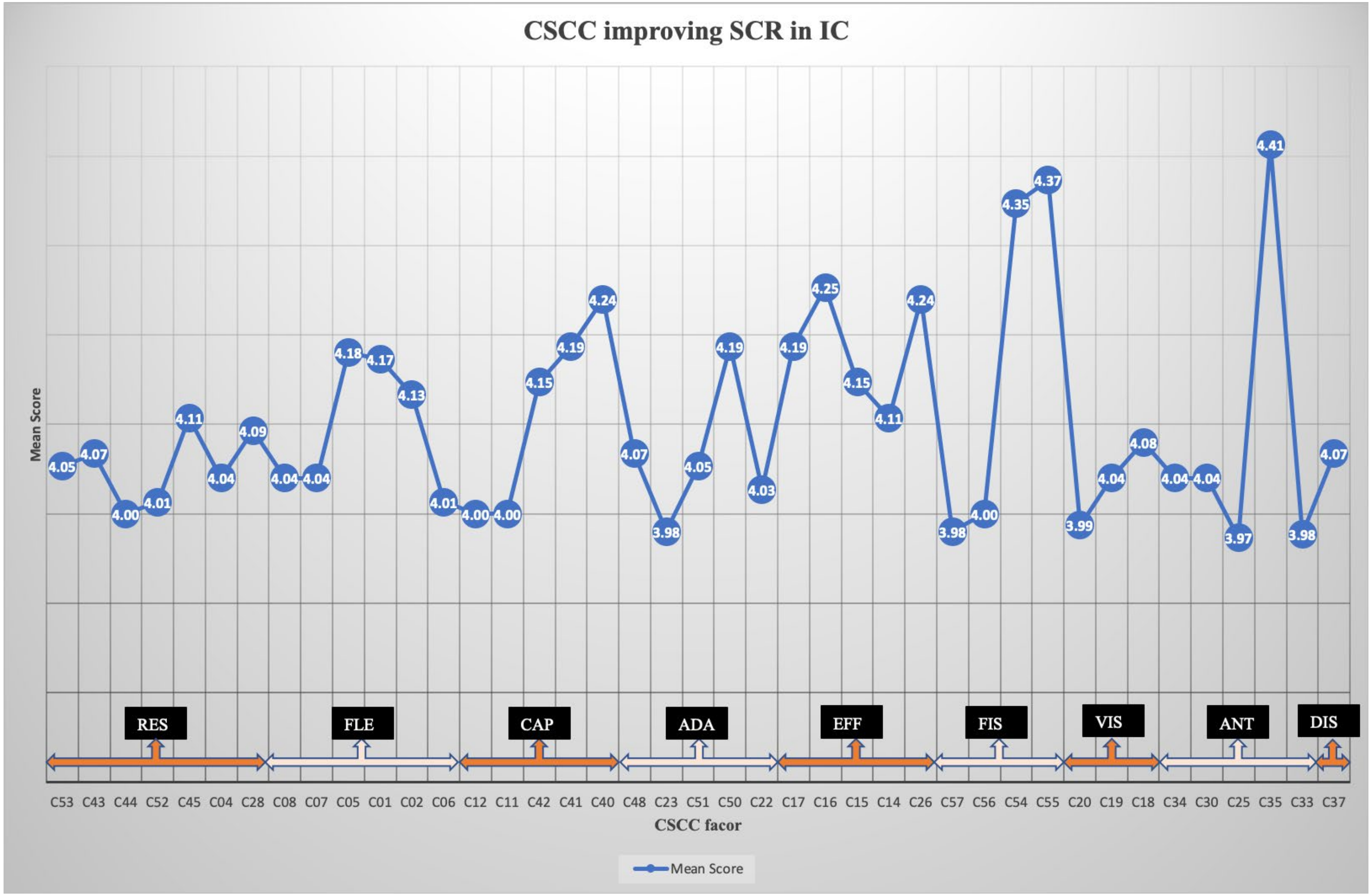


Fig.3. Critical Supply Chain Capabilities (CSCC) improving Supply Chain Resilience (SCR) in IC in HK

Table 1: SCC related to HK IC as retrieved after the preliminary study and ranking of CSCC in IC in HK

Adapted from Ekanayake et al. (2020)

Code	Supply Chain Capabilities	References	Mean	SD	SWT	N Value	Rank
C35	Quality control	[1] [2] [29] [32]	4.413	0.660	0.000	1.00[a]	1
C55	Good insurance coverage	[1] [2] [22] [23] [29] [32]	4.373	0.785	0.000	0.96[a]	2
C54	Financial reserves and funds	[1] [2] [17] [29] [30] [32]	4.347	0.707	0.000	0.93[a]	3
C16	Avoid variations/rework	[1] [2]	4.253	0.660	0.000	0.83[a]	4
C40	Professional response team	[1] [2] [29] [30] [43]	4.240	0.612	0.000	0.81[a]	5
C26	Learning from experience	[1] [2] [5] [12] [19] [20]	4.240	0.803	0.000	0.81[a]	6
C17	Failure prevention	[1] [2]	4.187	0.630	0.000	0.75[a]	7
C41	Effective communications strategy	[1] [2] [28] [29] [30] [43]	4.187	0.651	0.000	0.75[a]	8
C50	Close and healthy client-contractor relationships	[1] [2] [6] [14] [17] [28] [29] [32] [33] [37]	4.187	0.800	0.000	0.75[a]	9
C05	Alternate distribution channels/multimodal transportation	[1] [2] [5] [20] [28] [29] [30] [35] [37] [38] [39] [42]	4.180	0.734	0.000	0.75[a]	10
C01	Modular product design	[1] [2] [37]	4.173	0.724	0.000	0.74[a]	11
C42	Consequence mitigation	[1] [2] [29] [30] [34] [43] [44]	4.147	0.651	0.000	0.71[a]	12
C15	Higher labour productivity	[1] [2] [5] [19] [28] [29] [32]	4.147	0.748	0.000	0.71[a]	13
C02	Multiple uses	[1] [2] [5] [19]	4.133	0.741	0.000	0.70[a]	14
C14	Waste elimination	[1] [2] [3] [4] [19] [25] [26] [28] [29] [32] [38]	4.107	0.764	0.000	0.67[a]	15
C45	Obtain more competitive price from suppliers and subcontractors	[17]	4.107	0.781	0.000	0.67[a]	16
C28	Maintaining buffer time	[27] [34]	4.093	0.903	0.000	0.65[a]	17
C18	Products, assets, people visibility	[1] [2] [4] [7] [8] [9] [10] [30] [33] [38] [40] [42] [43]	4.080	0.712	0.000	0.64[a]	18
C48	Strong reputation for quality	[5] [14] [17] [19] [20] [22] [23] [28]	4.067	0.622	0.000	0.62[a]	19
C37	Distributed decision making	[1] [2] [33] [44]	4.067	0.704	0.000	0.62[a]	20
C43	Collaborative information exchange & decision making	[1] [2] [13] [18] [20] [28] [29] [30] [32] [33] [37] [38] [40] [42] [43]	4.067	0.704	0.000	0.62[a]	20
C51	Faster delivery	[5] [17] [19] [20] [22] [23] [28]	4.053	0.634	0.000	0.61[a]	22
C53	Personnel security	[1] [2] [29] [32]	4.053	0.884	0.000	0.61[a]	23

C08	Vertical integration	[14] [28] [33] [39] [41]	4.040	0.646	0.000	0.59[a]	24
C07	Production postponement	[1] [2] [28] [38]	4.040	0.706	0.000	0.59[a]	25
C30	Monitoring early warning signals	[1] [2] [19] [20] [29] [30] [43]	4.040	0.725	0.000	0.59[a]	26
C34	Deploying tracking and tracing tools	[16] [30] [32] [43]	4.040	0.725	0.000	0.59[a]	26
C19	Business intelligence gathering	[1] [2] [38]	4.040	0.743	0.000	0.59[a]	28
C04	Multiple sources/suppliers	[1] [2] [4] [7] [8] [10] [11] [14] [15] [19] [20] [21] [22] [23] [29] [30] [35] [37] [38] [39] [40] [42]	4.040	0.779	0.000	0.59[a]	29
C22	Fast rerouting of requirements	[1] [2] [5] [20] [29] [30] [33] [44]	4.027	0.735	0.000	0.58[a]	30
C13	Backup utilities	[1] [2] [29] [30] [32]	4.027	0.771	0.000	0.58[a]	31
C06	Risk pooling/sharing	[1] [2] [4] [7] [8] [10] [16] [20] [28] [30]	4.013	0.688	0.000	0.57[a]	32
C52	Cyber-security	[1] [2] [29] [32]	4.013	0.878	0.000	0.57[a]	33
C11	Redundancy	[1] [2] [7] [9] [14] [19] [20] [21] [35] [43]	4.000	0.697	0.000	0.55[a]	34
C12	Backup equipment facilities	[1] [2] [5] [15] [16] [19] [24] [27] [30] [32] [35] [40] [43]	4.000	0.735	0.000	0.55[a]	35
C56	Portfolio diversification	[1] [2] [28] [29] [32]	4.000	0.805	0.000	0.55[a]	36
C44	Collaborative forecasting	[1] [2] [30] [38] [43]	4.000	0.870	0.000	0.55[a]	37
C20	Efficient IT system & information exchange	[1] [2] [29] [30] [32] [33] [36] [38] [41] [43]	3.987	0.811	0.000	0.54[a]	38
C23	Lead time reduction	[1] [2]	3.980	0.743	0.000	0.53[a]	39
C57	Good price margin	[1] [2] [29] [32] [38] [43]	3.980	0.892	0.000	0.53[a]	40
C33	Cross training/intensive training	[14] [29] [30] [41] [43]	3.977	0.715	0.000	0.53[a]	41
C25	Alternative innovative technology development	[1] [2] [13] [16] [29] [43]	3.973	0.735	0.000	0.52[a]	42
C49	Market share of the organisations	[1] [2] [5]	3.947	0.543	0.000	0.49	43
C32	Risk management	[1] [2] [4] [5] [6] [7] [9] [30] [31] [34] [38] [43]	3.920	0.731	0.000	0.46	44
C03	Supplier contract flexibility	[1] [2] [5] [17] [19] [20] [28] [29] [30] [32] [35] [37] [39] [40] [42] [43]	3.920	0.850	0.000	0.46	45
C10	Reserves capacity/inventory buffers (materials, equipment & labor)	[1] [2] [7] [15] [23] [20] [21] [28] [29] [30] [32] [34] [35] [37] [38] [43]	3.893	0.746	0.000	0.43	46
C47	Public–private collaboration	[14] [43]	3.893	0.879	0.000	0.43	47
C24	Conducting process simulation	[1] [2]	3.867	0.905	0.000	0.41	48
C36	Business intelligence and disruption management research	[10] [19] [30]	3.800	0.805	0.000	0.33	49

C46	Procure materials globally	[17]	3.800	0.900	0.000	0.33	50
C09	Integrating inventory management with SCM tools	[1] [2] [16] [18] [27] [28] [33] [35] [37]	3.760	0.694	0.000	0.29	51
C21	Finite capacity scheduling tools with procurement visibility/e-procurement	[18] [38]	3.760	0.836	0.000	0.29	52
C31	Forecasting/predictive analysis	[1] [2] [19] [20] [29] [32] [37] [43]	3.733	0.723	0.000	0.26	53
C39	Decentralization of key resources	[1] [2] [44]	3.733	0.844	0.000	0.26	54
C38	Distributed capacity and assets	[1] [2] [44]	3.653	0.846	0.000	0.17	55
C27	Deploying IT based reporting tools	[16] [29] [30] [32] [33]	3.613	0.985	0.000	0.13	56
C29	Conducting parallel operations	[7] [19] [28] [38]	3.493	0.906	0.000	0.00	57
Factors removed during the preliminary study							
1	Brand equity of the organizations	[1] [2] [14] [29]	Not highly influential in the construction industry since IC is practiced in the industry by the reputed construction organizations which had already developed significant brand equity within the industry. Hence, this factor was removed after the preliminary study.				

1=(Zainal and Ingirige, 2018); 2=(Pettit et al., 2013); 3=(Mensah and Merkuryev 2014); 4=(Soni et al., 2014); 5=(Tang, 2006); 6=(Bueno-Solano and Cedillo-Campos, 2014); 7=(Christopher and Peck, 2004); 8=(Jüttner and Maklan, 2011); 9=(Scholten et al., 2014); 10=(Johnson et al., 2013); 11=(Lengnick-Hall et al., 2011); 12=(Kristianto et al., 2014); 13=(Scholten and Schilder, 2015); 14=(Ali et al., 2017); 15=(Ivanov et al., 2017); 16=(Brusset and Teller, 2017); 17=(Lim et al., 2011); 18=(Vaidyanathan and O'Brien, 2004); 19=(Sheffi and Rice Jr, 2005); 20=(Peck, 2005); 21=(Tomlin, 2006); 22=(Dong and Tomlin, 2012); 23=(Wang et al., 2010); 24=(Kim and Tomlin, 2013); 25=(Panova and Hilletofth, 2018); 26=(Wedawatta et al., 2010); 27=(Zavala et al., 2018); 28=(Chaghooshi et al., 2018); 29=(Chowdhury and Quaddus, 2017); 30=(Chowdhury and Quaddus, 2016); 31=(Ambulkar et al., 2015); 32=(Chowdhury and Quaddus, 2015); 33=(Wieland and Wallenburg, 2013); 34=(Colicchia et al., 2010); 35=(Purvis et al., 2016); 36=(Singh and Singh, 2019); 37=(Shahbaz et al., 2019); 38=(Rajesh, 2019); 39=(Gosling et al., 2013); 40=(Namdar et al., 2018); 41=(Riley et al., 2016); 42=(Mandal et al., 2016); 43=(Machado et al., 2018); 44=(Treiblmaier, 2018)

Note: SD = Standard Deviation
N Value = Normalization Value = (Mean-Minimum Mean)/(Maximum Mean-Minimum Mean)
[a] indicates the normalised value > 0.50 and considered as a critical SCV
SWT = Shapiro-Wilk test

Table 2: Key summary of the factor analysis results and the developed components

Code CSCC improving SCR in IC in HK	Component									
	1	2	3	4	5	6	7	8	9	$\bar{x} = \sum xi / n$
Component 1-Resourcefulness (RES)										4.053
C53 Personnel security	.768	-	-	-	-	-	-	-	-	4.053
C43 Collaborative information exchange & decision making	.702	-	-	-	-	-	-	-	-	4.067
C44 Collaborative forecasting	.656	-	-	-	-	-	-	-	-	4.000
C52 Cyber-security	.655	-	-	-	-	-	-	-	-	4.013
C45 Obtain more competitive price from suppliers and subcontractors	.607	-	-	-	-	-	-	-	-	4.107
C04 Multiple sources/suppliers	.588	-	-	-	-	-	-	-	-	4.040
C28 Maintaining buffer time	.581	-	-	-	-	-	-	-	-	4.093
Component 2-Flexibility (FLE)										4.097
C08 Vertical integration	-	.761	-	-	-	-	-	-	-	4.040
C07 Production postponement	-	.756	-	-	-	-	-	-	-	4.040
C05 Alternate distribution channels/multimodal transportation	-	.691	-	-	-	-	-	-	-	4.180
C01 Modular product design	-	.675	-	-	-	-	-	-	-	4.173
C02 Multiple uses	-	.641	-	-	-	-	-	-	-	4.133
C06 Risk pooling/sharing	-	.638	-	-	-	-	-	-	-	4.013
Component 3-Capacity (CAP)										4.115
C12 Backup equipment facilities	-	-	.819	-	-	-	-	-	-	4.000
C11 Redundancy	-	-	.657	-	-	-	-	-	-	4.000
C42 Consequence mitigation	-	-	.567	-	-	-	-	-	-	4.147
C41 Effective communications strategy	-	-	.511	-	-	-	-	-	-	4.187
C40 Professional response team	-	-	.500	-	-	-	-	-	-	4.240
Component 4-Adaptability (ADA)										4.063
C48 Strong reputation for quality	-	-	-	.839	-	-	-	-	-	4.067
C23 Lead time reduction	-	-	-	.704	-	-	-	-	-	3.980

C51 Faster delivery	-	-	-	.674	-	-	-	-	-	4.053
C50 Close and healthy client-contractor relationships	-	-	-	.521	-	-	-	-	-	4.187
C22 Fast rerouting of requirements	-	-	-	.429	-	-	-	-	-	4.027
Component 5-Efficiency (EFF)										4.187
C17 Failure prevention	-	-	-	-	.730	-	-	-	-	4.187
C16 Avoid variations/rework	-	-	-	-	.725	-	-	-	-	4.253
C15 Higher labour productivity	-	-	-	-	.668	-	-	-	-	4.147
C14 Waste elimination	-	-	-	-	.531	-	-	-	-	4.107
C26 Learning from experience	-	-	-	-	.497	-	-	-	-	4.240
Component 6-Financial Strength (FIS)										4.175
C57 Good price margin	-	-	-	-	-	.876	-	-	-	3.980
C56 Portfolio diversification	-	-	-	-	-	.804	-	-	-	4.000
C54 Financial reserves and funds	-	-	-	-	-	.468	-	-	-	4.347
C55 Good insurance coverage	-	-	-	-	-	.407	-	-	-	4.373
Component 7-Visibility (VIS)										4.036
C20 Efficient IT system & information exchange	-	-	-	-	-	-	.849	-	-	3.987
C19 Business intelligence gathering	-	-	-	-	-	-	.766	-	-	4.040
C18 Products, assets, people visibility	-	-	-	-	-	-	.511	-	-	4.080
Component 8-Anticipation (ANT)										4.089
C34 Deploying tracking and tracing tools	-	-	-	-	-	-	-	.731	-	4.040
C30 Monitoring early warning signals	-	-	-	-	-	-	-	.653	-	4.040
C25 Alternative innovative technology development	-	-	-	-	-	-	-	.556	-	3.973
C35 Quality control	-	-	-	-	-	-	-	.528	-	4.413
C33 Cross training/intensive training	-	-	-	-	-	-	-	.484	-	3.977
Component 9-Dispersion (DIS)										4.067
C37 Distributed decision making	-	-	-	-	-	-	-	-	.783	4.067
Eigenvalue	18.488	3.094	2.579	2.218	1.928	1.692	1.291	1.146	1.069	-
Variance (%)	44.018	7.368	6.140	5.281	4.591	4.027	3.075	2.728	2.545	-
Cumulative variance (%)	44.018	51.386	57.525	62.806	67.397	71.425	74.500	77.228	79.773	-
KMO measure of sampling adequacy										.810

Bartlett's test of sphericity approximated chi-square	3370.583
Df	861
Sig.	.000

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
$\bar{x} = {\sum xi}/{n}$; where $\bar{x}$ = mean, $\sum xi$ = summation of sampled frequency; n = number of responses for a variable or the number of items in a specific component.