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Capabilities to Withstand Vulnerabilities and Boost Resilience in Industrialized Construction Supply Chains: A Hong Kong Study

Abstract

Purpose: Given the heightened imperatives for boosting Supply Chain Resilience (SCR) in Industrialized Construction (IC), it is essential to explore the correlational impacts of Supply Chain Vulnerabilities (SCV) and Supply Chain Capabilities (SCC) which are the measures of SCR, specifically in Hong Kong (HK) where policymakers actively promote IC. Therefore, this study aimed to develop a model to explore the correlational impacts of vulnerabilities and capabilities targeting SCR in IC.

Design/methodology/approach: After drawing on the general literature on SCR, empirical research using an expert opinion survey was conducted following the methodological framework of this study. The gathered data were then subjected to the partial least squares structural equation modelling process. Thereby, four hypotheses were formulated and tested for 20 capability-vulnerability relationships.

Findings: Seven of the 20 statistical relationships tested were identified to be significant. Accordingly, production-based SCV were identified as the most critical disruptions. 'Resourcefulness' could substantially withstand production-based SCV, receiving the highest path significance. An 'enablers-results framework' for achieving SCR of IC was also developed based on these findings to help industry practitioners with SCR implementation.

Originality/value: To the authors' knowledge, this is the first structured evaluation model that measures the correlational impacts of SCC and SCV targeting SCR in the construction domain. Further, this study adds substantially to the existing SCR and construction 'body of knowledge' by proposing a model explaining how various SCV and SCC influence SCR in IC. These findings also inform the industry where and how to deploy critical SCC at appropriate levels, targeting critical SCV, to contain or extirpate them.

Keywords: Industrialized Construction; Supply Chain Resilience; Partial Least Squares Structural Equation Modelling (PLS-SEM); Supply Chain Vulnerabilities; Supply Chain Capabilities

1. Introduction

Industrialized Construction (IC) has emerged as an attractive construction approach, providing a more sustainable, better quality, cleaner and safer working environment (Wang et al., 2021). IC improves the triple bottom line of sustainability because (a) standardization and 'leanness' of the processes facilitate economic sustainability; (b) reductions in workforce, waste and resources, and enhanced reusability address environmental sustainability; and (c) advanced on-site technology and automation boost social sustainability (Li et al., 2020), while targeting enhanced occupational health and safety (Pan et al., 2008). Indeed, IC transforms high-consumption, high-waste and labor-intensive traditional construction practice to a value-driven, more green and sustainable construction approach (Wang et al., 2021; Wuni and Shen, 2020). IC's primary focus is to create a controlled onsite assembly process through manufacturing or factory-based production (Arif and Egbu, 2012). This process comprises three fundamental supply chain phases of prefabrication; transportation; and on-site assembly (Zhai et al., 2019). Despite the expected efficiencies and espoused benefits of IC, each IC supply chain phase is affected by numerous Supply Chain Vulnerabilities (SCV) (Ekanayake et al., 2020a), contributing to supply chain inefficiencies and low construction productivity. The level of supply chain's vulnerability does not simply depend on the severity and duration of the disruptive event as considered in supply chain risk management. Still, it highly depends on the capability of the supply chain to withstand the risks or the disruptions (Ekanayake et al., 2020a). Therefore, the planned sustainability and performance targets can not be achieved without successfully overcoming or containing these SCV through enhanced SCC.

In response, Supply Chain Resilience (SCR) has recently increased in prominence (Gölgeci and Kuivalainen, 2020) as a requisite element in sophisticated risk management practices to withstand SCV. In essence, SCR goes beyond the traditional risk management practices, facilitates the organizational capacity to recover from severe vulnerabilities, and react efficiently to unexpected disruptions while restoring quickly to its normal operations (Sheffi and Rice, 2005). For this, resilient supply chains need to develop proactive 'Supply Chain Capabilities' (SCC), enabling supply chains to prepare and respond effectively to adverse uncertainties and disruptions (Ponomarov and Holcomb, 2009). These proactive capabilities may delay disruptions, reduce their impact, and help to withstand them robustly within acceptable degradation parameters or enable effective recovery within the acceptable cost, time, and risk parameters (Gölgeci and Kuivalainen, 2020). Therefore, it is pivotal to SCR to nurture and embed essential SCC at appropriate levels in IC supply chains targeting more resilient, sustainable and performance-enhanced IC practices (Ekanayake et al., 2020a).

Under these circumstances, it was found mandatory to identify the common and significant SCV and the relevant counter-balancing SCC [as the measures of SCR] to determine the potential resilient levels that may be attained in IC supply chains. Since a previous study that identified a set of SCV and SCC considering IC supply chains was not found in the literature, Ekanayake et al. (2020a) and Ekanayake et al. (2020b) identified SCV and SCC of IC, respectively, based on meta-analysis and the systematic review of the SCR knowledge domain in general. Since it was also found that these SCV and SCC are jurisdiction-specific, subsequent parallel empirical research exercises, as reported by Ekanayake et al. (2020c) and Ekanayake et al. (2020d), next enabled identification of the critical SCV and SCC that need consideration in developing resilient supply chains in IC practice in Hong Kong (HK). HK is a high-density city liable to acute disruptions in IC supply chains, for reasons such as the dire shortage of skilled labour, an ageing workforce, space constraints, and escalating costs (Zhai et al., 2019). These disruptions have alerted the HK industry to needs for developing SCR in the IC sub-sector, thereby prompting the HK-based case study to investigate the true potential. Besides, the nature of the supply chains, allied vulnerabilities, and the capability requirements differ from country to country and industry to industry due to the associated supply chain dynamics of each jurisdiction or industry (Ekanayake et al., 2020d). These foregoing essentials expanded on and intensified the need for more profound studies investigating SCR aspects considering IC in HK.

Although the stated precursor publications identified the critical SCV and SCC in IC in HK, they did not attempt to explore the correlational impacts of SCC and SCV in terms of effective withstanding of the identified SCV in IC in HK. Identifying these co-relational impacts is critical to determine which specific supply chain capabilities are more likely to mitigate specific supply chain vulnerabilities. Further, it would have been a wasted opportunity to achieve specific major breakthroughs in theory and practice, if the authors had stopped after merely identifying the separate lists of vulnerabilities and capabilities since SCR only can be achieved through maintaining an appropriate and well-focused supply chain vulnerability-capability balance. Therefore, identifying these co-relational impacts is essential for the ultimate 'bottom-line' industry to detect the impact levels of SCC on SCV, thereby proposing the more influential and significant capability-vulnerability relationships. Only then would industry practitioners be able to deploy appropriate capabilities at suitable times and at appropriate levels to counteract relevant SCV and sustain resilience targets by drawing on or 'operationalizing' these findings of the reported co-relational impact analysis. Moreover, this methodology and the value of the findings may also trigger further studies in other construction management scenarios since no known research has identified the significant correlational impacts of SCC and SCV, even for conventional (non-IC) construction supply chains.

On the other hand, partial least squares-structural equation modelling (PLS-SEM) has received considerable attention in construction research (Darko et al., 2018; Kineber et al., 2021) to explore the co-relational impacts of different constructs. In particular, concerning SCR in construction, such kinds of studies are nonexistent. However, Abeysekara et al. (2019) have successfully investigated the influence of supply chain complexity on SCC's effectiveness in mitigating disruptions in the Sri Lankan apparel industry using the PLS-SEM approach. Chowdhury and Quaddus (2017) also attempted to study SCR using PLS-SEM in the Bangladesh apparel industry. Dubey et al. (2019) tested organizational flexibility and data analytics capability as complements to SCR in Indian manufacturing firms, providing another successful PLS-SEM application in the SCR knowledge domain. The findings from these studies relating to best practices of manufacturing provided useful relevant insights. They encouraged a focused study, including a correlational analysis of SCC and SCV in industrialized construction supply chains.

Having identified the research need in IC through the given research background and based on the insights gained from the successful application of PLS-SEM to assess co-relational impacts of SCC and SCV in other industries; this study aimed to examine and model the impact of SCC on withstanding SCV, targeting resilient supply chains in IC in HK. Building on the authors' already published precursor findings [Ekanayake et al. (2020c, 2020d)], this study investigates causal relationships between SCC and SCV and the effectiveness of the capabilities. This dimension renders this research more significant since the study transcends the analysis of the SCC's and SCV's criticality and identifies the relational impacts of one on the other. In this case, the findings are skewed towards IC in HK since the constructs were assessed, hypotheses were tested, and the model was developed in the specific context of HK. However, this study is useful in a broader context since the methodology can be adapted, and specific findings can be generated in similar scenarios. It is also significant because its findings could be useful in both practice and conceptualisation, as well as in theory-building. First, the findings on the co-relational impact of SCC on SCV help professional practitioners make better decisions by selecting appropriate capabilities to counteract specific vulnerabilities in a given scenario, enabling more resilient and sustainable IC practices in HK. Second, as no studies explore the relative impacts of SCV and SCC targeting SCR within the construction domain, this research expands the existing SCR and construction literature by proposing a model that explains how various SCV and SCC influence the SCR adoption in IC, considering the HK case. Ultimately and more broadly, this research directs the construction industry towards resilient, value-enhanced and sustainable practice in general. Although this study is focused on HK, the developed research framework and methodology provide a solid and tested foundation for extensive worldwide studies in this research domain (as supply chain dynamics are jurisdiction-specific). Hence, the findings and implications could benefit industry professionals worldwide (as most of the supply chains are globally linked). Although the data collection and initial analysis for this study were just before the onset of COVID 19 (which brought significant disruptions), the recent worldwide upheavals in general, including supply chain disruptions from the pandemic, will surely increase the relevance and significance of the methodology and findings. The forthcoming sections of this paper describe the steps in developing the research framework and the hypothesis, research methods used throughout the study, key results and findings, the evaluation of developed models, discussion of the findings, research implications, and conclusions derived with possible ways forward.

2. Research Framework and Hypotheses

2.1 Research framework

A research framework can be either established based on theory or logic, or both, and it is beneficial in creating new knowledge in a specific research domain (Darko et al., 2018). The research framework developed in this study has both theoretical and logical underpinnings. According to Pettit et al. (2013), SCR entails two constructs (i) vulnerabilities - the key factors which make supply chains susceptible to disruptions and (ii) capabilities - attributes which enable supply chains to perform better and anticipate and withstand disruptions. Expanding on these, Pettit et al. (2013) showed how creating a capability portfolio can counteract the inherent SCV, leading to a balanced resilience as hypothesized to improved supply chain performance. The 'Contingency Theory' is considered an appropriate framework for discussing proactive management strategies of supply chains, especially in mitigating unexpected disruptions (Grötsch et al., 2013).

Further, a contingent resource-based view posits that sustained competitive advantage can be gained through resource generation and regeneration of existing capabilities (Brandon-Jones et al., 2014). Besides, a 'Dynamic Capability View' provides deep insights into the delineation of capabilities during dynamic and uncertain environments (Teece et al., 1997). Also, it enables the determination of appropriate resources and capabilities to respond to dynamic changes by focusing on the idiosyncrasies of various contingencies (Teece et al., 1997; Chowdhury and Quaddus, 2017). In line with the principles and propositions of 'dynamic capability', this study postulates that organizational supply chains need to create dynamic capabilities to withstand vulnerabilities under a tumultuous supply chain environment, necessitating the deployment of suitable SCR capabilities in value-creating strategies in the long run.

Therefore, dynamic capabilities can be considered to be the sources of SCR (Ambulkar et al., 2015), empowering organizations with adaptive capacities. These resilience capacities are two-fold: (a) proactive capabilities [provide withstanding abilities to the supply chains] and (b) reactive capabilities [provide abilities of supply chains to respond to change by adapting their initial stable configurations (Wieland and Wallenburg, 2013). In this regard, agility and robustness enhance resilience capability (Wieland and Wallenburg, 2013) while visibility, dual-sourcing, transhipping (Christopher and Peck, 2004), flexibility (Tomlin, 2006), and leanness (Purvis et al., 2016) also protect against supply chain threats. Pettit et al. (2013) established a 13-factor capability assessment tool for manufacturing and service firms by advancing the SCR theory. In an example from practice, Chowdhury and Quaddus (2015) findings on SCC were significant for the Bangladesh garment industry. Zainal and Ingirige (2018) also proposed 12 capabilities to improve Malaysian construction projects based on previous theory developments and considering supply chain dynamics. Inspired by these useful contributions to SCR theory, Ekanayake et al. (2020d) established a nine supply chain capability constructs model with forty-one capability measurement items concerning IC in HK. Fig.1 presents all these identified supply chain capability measurement items with their codes. It was postulated that the IC firms should reconfigure resources and processes by building strengths aligning with these capabilities to withstand and mitigate supply chain dynamics and turbulences.

Adverse supply chain dynamics and turbulences are triggered by SCV, leading to supply chain deficiencies. Furthermore, IC supply chains are relatively unchangeable and fixed once established, given long lead times for any project and expectations of business continuity after initial capital costs. This can further aggravate the impacts of disruptions affecting or triggered by even one supply chain member since it can propagate through a previously fixed and stable supply chain network (Zhai et al., 2019). These vulnerabilities can be the outcomes of a chain of events generating cascading effects contributing to each vulnerability (Zainal and Ingirige, 2018), requiring careful assessment and proactive remedies. Natural disasters, labor shortages and disputes, supply shortages, and quality problems (Chopra and Sodhi, 2004) are common attributes shared in the cluster of SCV. Besides, the tsunami-triggered Japanese triple disaster in 2011, the European migration crisis in 2015, SARS in 2003, and most recently, the COVID19 pandemic, global disruptions have adversely affected global supply chains to significant extents. In the context of manufacturing and service firms, Pettit et al. (2013) established seven supply chain vulnerability categories of deliberate threats, external pressures, turbulence, resource limits, connectivity, sensitivity, and supplier/customer disruptions. Zainal and Ingirige (2018) developed eleven supply chain vulnerability constructs based on a questionnaire survey in Malaysian public projects in the context of the built environment.

After identifying the research lacuna in IC, given its special conditions, constraints and context that militate against applying such a general classification based on manufacturing practices to IC, Ekanayake et al. (2020c) grouped twenty-four critical SCV into five underlying constructs through results generated from an empirical study, focusing IC practices in HK. Fig.1 further illustrates the constructs and the vulnerability measurement items created in the precursor studies of Ekanayake et al. (2020c, 2020d). Considering these theoretical underpinnings, this study rationale is developed on the premise that SCC act as counter-balancers of SCV in achieving resilient supply chains in IC in HK, as shown in Fig.1, the research framework proposed in this study. This proposed framework is quite beneficial in developing a better understanding of the dynamic supply chain culture underlying IC processes, myriad disruptions, their consequential impacts, and the dynamic capabilities that could effectively withstand these impacts. Further, this research framework is useful in analyzing the impact of capabilities on confronting vulnerabilities in the pursuit of SCR of IC in HK, as hypothesized and illustrated in the next section.

[Insert Fig.1. here]

2.2 Hypotheses development

This research focuses on the two research thrusts mentioned above: capabilities and vulnerabilities of SCR in IC. Resilient supply chains are essential for achieving performance-enhanced, more sustainable supply chains in IC. Therefore, a comprehensive research project was conducted to promote SCR capabilities in construction organizations and develop sustainable and cleaner construction processes thereby. During the initial stages of this research project, a set of SCV and SCC targeting SCR were first determined through a systematic and comprehensive literature search. Thereafter, critical SCV and critical SCC were extracted and grouped according to their underlying themes through an HK-based case study of IC. Details of these preliminary stages are presented in detail in the authors' previous papers (Ekanayake et al., 2020a,2020b,2020c,2020d). Supply chain vulnerability constructs included Economic (ESCV), Technological (TSCV), Procedural (PSCV), Organizational (OSCV), and Production-based (PBSCV) vulnerabilities (Ekanayake et al., 2020c). Supply chain capability constructs are Resourcefulness (RES), Flexibility (FLE), Anticipation (ANT), Dispersion (DIS), Capacity (CAP), Adaptability (ADA), Efficiency (EFF), Financial Strength (FIS), and Visibility (VIS)

(Ekanayake et al., 2020d). These SCC are the precursors to the SCR implementation so that when better understood and appropriately adopted in the projects, they can help generate the envisaged resilient supply chains. Therefore, the five supply chain vulnerability constructs and nine supply chain capability constructs that were developed, were used to assess the SCR in this study. Insights from the literature confirm that SCC help withstand relevant SCV (Pettit et al., 2013). Targeting resilient supply chains, it can be postulated that SCC negatively influence SCV. Therefore, at the beginning of this study, all these nine supply chain capability constructs were tested for their impact on the five supply chain vulnerability constructs. However, from the 1st path-correlation of PLS-SEM analysis, only four of the supply chain capability components, namely, capacity, dispersion, flexibility, and resourcefulness, showed significant results. Therefore, based on the above results, the insights mentioned above, and the research framework (Fig.1), the following key research hypotheses were postulated.

H1. Resourcefulness-related SCC have a negative influence on all five SCV constructs

> ***H1a.*** *Resourcefulness-related SCC have a negative influence on Economic SCV*
>
> ***H1b.*** *Resourcefulness-related SCC have a negative influence on Procedural SCV*
>
> ***H1c.*** *Resourcefulness-related SCC have a negative influence on Production-based SCV*
>
> ***H1d.*** *Resourcefulness-related SCC have a negative influence on Organizational SCV*
>
> ***H1e.*** *Resourcefulness-related SCC have a negative influence on Technological SCV*

H2. Flexibility-related SCC have a negative influence on all five SCV constructs

> ***H2a.*** *Flexibility-related SCC have a negative influence on Economic SCV*
>
> ***H2b.*** *Flexibility-related SCC have a negative influence on Procedural SCV*
>
> ***H2c.*** *Flexibility-related SCC have a negative influence on Production-based SCV*
>
> ***H2d.*** *Flexibility-related SCC have a negative influence on Organizational SCV*
>
> ***H2e.*** *Flexibility-related SCC have a negative influence on Technological SCV*

H3. Dispersion-related SCC have a negative influence on all five SCV constructs

> ***H3a.*** *Dispersion-related SCC have a negative influence on Economic SCV*
>
> ***H3b.*** *Dispersion-related SCC have a negative influence on Procedural SCV*
>
> ***H3c.*** *Dispersion-related SCC have a negative influence on Production-based SCV*
>
> ***H3d.*** *Dispersion-related SCC have a negative influence on Organizational SCV*

H3e. Dispersion-related SCC have a negative influence on Technological SCV

H4. Capacity-related SCC have a negative influence on all five SCV constructs

H4a. Capacity-related SCC have a negative influence on Economic SCV

H4b. Capacity-related SCC have a negative influence on Procedural SCV

H4c. Capacity-related SCC have a negative influence on Production-based SCV

H4d. Capacity-related SCC have a negative influence on Organizational SCV

H4e. Capacity-related SCC have a negative influence on Technological SCV

Five sub hypotheses were developed under each hypothesis by extending each capability construct's influence on all the five supply chain vulnerability constructs; hence a total of 20 sub-hypotheses were postulated as listed above and as shown in Fig.2. Moreover, it is assumed that all the constructs captured in SCC have a potentially significant influence on all SCV to avoid any subjective skewing of hypotheses that could compromise this study. Accordingly, a model to visualize the study hypotheses was developed by including all the 20 sub-hypotheses, as in Fig. 2.

[Insert Fig.2. here]

3. Research Methods

A questionnaire was developed following a comprehensive and systematic review of the literature and pilot testing with four professors experienced in both industry and academia. An expert opinion survey was conducted following the pilot study using purposive, then snowball sampling approaches considering their appropriateness to this study. After that, the collected data were pre-tested for reliability and appropriateness, and data normalization was carried out, thereby completing the initial data screening process. Finally, the main analysis was conducted with the use of PLS-SEM. A summary of the research framework adopted in this study is shown in Fig. 3 and explained in the succeeding sections.

[Insert Fig.3. here]

3.1. Data collection

An expert opinion survey using a questionnaire as the primary data collection method was employed in this study, considering its appropriateness and the advantages of this method's applicability, superior feasibility, and data relevance (Ameyaw et al., 2017; Owusu et al., 2020). Without limiting to the deductive research approach, semi-structured interviews were also conducted to collect data as the element of interpretivism was found useful, indeed important, in seeking and providing industry-based justifications for the quantitative results. Therefore, all the respondents were contacted either face-to-face or through online interviews. A brief description of the survey was conveyed at the beginning of the interviews, including the requirements of this data collection, after which they were requested to fill the questionnaire. Purposive sampling, regarded as a non-probabilistic sampling method, was employed in data collection (Darko et al., 2018). The Snowball sampling approach thereafter enabled the widening of the experts' 'catchment area'. These approaches helped gather valid responses from the experts who are very knowledgeable and well experienced with common IC practices. Further, this study did not use a sampling frame since the non-probability sampling method was employed (Darko et al., 2018). A questionnaire including both open and closed-ended questions was used for primary data collection. These questions captured the vitality of the SCV and SCC. The experts were requested to grade the criticality of the given supply chain vulnerability and capability measurement items across a five-point Likert scale. Supply chain capability measurement items were measured using the grading scale; 1=not important to 5=highly important. The SCV were graded using two components of probability and severity, where 1=not probable/severe to 5=highly probable/severe. This rating system has been proven to be an appropriate measure of risk perception indicators in assessing vulnerabilities (Ameyaw et al., 2017). Accordingly, seventy-six valid responses were gathered for analysis (the respondents' profile is presented in Table 1). These respondents were identified by exploring their business profiles, attending seminars related to IC conducted by them, and industry-based contacts. All the respondents were managerial or high-level industry experts working/worked in IC projects in HK with significant knowledge in this area. This justifies the validity of their responses. Many project engineers assigned to the manufacturing factory were also involved in this study to enable rich data gathering. At the same time, all the respondents were asked to provide their answers considering all the supply chain phases to maintain the consistency of the data collected. The sample size of this study is regarded as adequate for the analysis (Sproull, 2002) since a sample size of 30 is representative of any group (Ott and Longnecker, 2015). Also, this response rate is relatively high compared to similar PLS-SEM construction management related studies of Ameyaw et al. (2017), Darko et al. (2018) and Owusu et al. (2020). In the SCR domain, even the PLS-SEM study of Abeysekara et al. (2019) was based on 89 questionnaire responses, while Chowdhury and Quaddus (2017) used 15 interview responses. Indeed, the number of such experts in HK with ‘managerial level experience on IC projects’, i.e., the total population from which this sample is drawn, is itself not large, further justifying the reliability of findings derived from the sample of 76. Besides, the interview discussions were also useful in verifying and validating the questionnaire responses.

[Insert Table 1 here]

3.2. Data analysis

Structural Equation Modeling (SEM) is a useful multivariate statistical analysis tool employed to test the postulated hypotheses. In SEM analysis, the two possible approaches are: covariance-based (CB-SEM) and variance-based (PLS-SEM) (Hair et al., 2014). However, this study used PLS-SEM since this analysis tool can process with small sample sizes and non-normal data, and as it can generate significant results with small data samples (Hair et al., 2014). Although there are arguments for using PLS-SEM (Dijkstra, 1983; Fornell and Bookstein, 1982), this method has been successfully employed in construction management research studies widely to date and has yielded substantial research outputs (Darko et al., 2018; Owusu et al., 2020; Kineber et al., 2021). In terms of SCR research, one of the significant studies, namely, Chowdhury and Quaddus (2017), also used the same research method to investigate the co-relational impacts of SCC and SCV in the Bangladesh apparel industry. Besides, this method advances the commonly used methods of multiple regression analysis, variance, and factor analysis (Darko et al., 2018). It enables path analysis and confirmatory factor analysis within a single model (Xiong et al., 2015). Given these advantages and justifications based on PLS-SEM's successful application in similar previous studies, this study also adopted the PLS-SEM technique to achieve the research aim, which is explicated above. The SmartPLS 3.3.2 software was deployed in the current analysis and enabled testing the research hypotheses and validating the developed hypothetical models. The analysis was conducted under three stages of (I) model specification, (II) outer model evaluation, and (III) reflective indicators (Hair et al., 2014). Fig. 2 presents the hypothetical model developed, including exogenous (SCC) and endogenous (SCV) constructs. Each supply chain capability construct comprises formative indicators (supply chain capability measurement items), whereas each supply chain vulnerability construct comprises reflective indicators (supply chain vulnerability measurement items). These capability and vulnerability measurement items are the observable variables in this model and referred to as the 'measurement items' hereafter. Further, the developed constructs are the latent variables that cannot measure directly. The PLS-SEM algorithm was run during the outer model evaluation (Henseler et al., 2012), and the reliability and the validity of the outer model constructs were evaluated. Accordingly, reflective outer model indicators were assessed for internal consistency, reliability, and validity using Cronbach's alpha and composite reliability scores. The postulated model is considered to be reliable when Cronbach's alpha > 0.70 (Nunnally, 1978) and composite reliability scores > 0.70 (Hair et al., 1998). After verifying the reliability as above, the validity was assessed through the construct's convergent validity and discriminant validity. Convergent validity is supported when each item's outer loading > 0.70 and each construct's average variance extracted (AVE) ≥ 0.50 (Hair et al., 2014). AVE presents the grand mean value of a construct's squared loadings equivalently to the construct's commonality (Hair et al., 2014). Discriminant validity was verified using the Fornell and Larcker (1981) criterion and the indicators' cross-loadings. The first criterion is satisfied if a construct variance (AVE), including its measurement items, is greater than what it shares with other constructs. The second criterion is supported if each measurement item's loading on its respective construct is higher than the cross-loadings on other constructs. Finally, the significant weight of each path (path coefficient) was computed using the bootstrapping technique in PLS-SEM. As Hair et al. (2011) suggested, the number of bootstrap samples used was 5000, ensuring the richness of the findings. Further, the two-tailed tests' critical t-values were 1.65, 1.96, and 2.56, with significance levels of 10%, 5%, and 1%, respectively (Hair et al., 2011). Subsequent sections elaborate on the results generated in this study, followed by the discussions of these results.

4. Results

4.1. Evaluation of measurement model

Table 2 and Table 3 present the final evaluation results of the supply chain capability measurement model's influence in withstanding SCV targeting SCR in IC in HK. Since the factor loadings of TSCV1, TSCV4, and TSCV5 measurement items were less than 0.50, the authors deleted them from the model in order to develop the best-fit model. Besides, measurement items loaded with low figures should be avoided since their contribution is insignificant to the model's explanatory power (Nunnally, 1978). Accordingly, the PLS algorithm was rerun until a valid and reliable measurement model was achieved. According to Table 2, Cronbach's alpha coefficients of all the constructs were above 0.70 and similarly, the composite reliability scores were higher than 0.70. The results indicated that the measurement model is internally consistent and reliable. Further, all factor loadings and AVE values were above 0.50. The AVE value ≥ 0.50 denotes a sufficient degree of convergent validity when a latent variable explains greater than 50% of its indicators' variance (Hair et al., 2011). Therefore, the results of this study support with evidence the convergent validity of the constructs. As presented in Table 3, each latent construct's AVE value is greater than the respective construct's highest squared correlation with another construct by fulfilling the Fornell–Larcker criterion. Similarly, each measurement item's loading on the parent construct was higher than the other cross-loadings, justifying the discriminant validity of the constructs. Therefore, these results cleared the way forward for the envisaged structural path modelling by providing evidence to support the measurement model's reliability and validity.

[Insert Table 2 & Table 3 here]

4.2. Evaluation of structural model

Table 4 indicates the bootstrapping results of the PLS-SEM structural model developed in this study. According to the results, paths linking CAP-PBSCV, FLE-ESCV, RES-OSCV, and RES-PSCV had a *t*-value above 1.96, indicating that these paths were statistically significant at the level of 0.05. Therefore, H4, H1, and H2 hypotheses were appropriately supported. The paths linking DIS-ESCV, RES-ESCV and RES-PBSCV had *t*-values greater than 2.56, indicating that these paths are statistically significant at the 0.01 level. Hence, hypotheses H3 and H1 were also appropriately supported. Besides, the higher path coefficient implies a more substantial influence on the variables (Aibinu and Al-Lawati, 2010). Fig.4. clearly shows each path coefficient's strength in the PLS-SEM model of the impact of SCC on withstanding SCV in achieving SCR in IC in HK. The thicker the path lines, the stronger the path influence. Therefore, the most robust path is between RES and PBSCV, implying the most substantial influence in achieving resilient supply chains in IC. The coefficients of determination (R^2) value of the dependant variables were greater than 0.3. On the most substantial path of PBSCV, it was 0.518. Therefore, this further confirmed the model's quality and predictive accuracy (Hair et al., 2014).

[Insert Table 4 here]

5. Discussion

The model proposed in this study is based on the IC supply chains in HK as supply chain dynamics are jurisdiction specific. Therefore, these findings are validated specifically for the HK context. Indeed, this study identified the critical supply chain capability constructs with the allied significant paths and essential components of SCV, where HK industry professionals would need to pay particular attention. To facilitate the given study rationale, this section discusses the results generated from the PLS-SEM analysis from a good practice enhancement perspective. Therefore, each path's significance is explained further, considering the measurement items included in the appropriate supply chain vulnerability and capability constructs as follows.

5.1 Resourcefulness (Res) → Production-based SCV (PBSCV)

The PLS-SEM model supported a significantly negative influence of resourcefulness towards production-based SCV. The results identified this path as the most significant path, demarcating resourcefulness as the most critical capability needed by IC supply chains in HK. The results also suggested the production-based vulnerability construct as the most critical vulnerability group where greater attention is required. It can be further interpreted that the higher the resourcefulness, the less the supply chain disruptions due to production-based SCV, and the higher the withstanding capacity of IC supply chains. Since production-based SCV are allied with the production process of IC, a collaborative and resourceful approach seems very important for withstanding production-based SCV; hence, collaborative resourcefulness is suggested to be effective. In line with the findings of Ekanayake et al. (2020c), quality loss, supply-demand mismatch/shortages, and labor disputes are the most significant supply chain disruptions in IC in HK, grouped in PBSCV construct. Unless an appropriate tolerance is ensured in the factory, quality losses make the assembly process challenging (Ekanayake et al., 2020d).

On the other hand, a supply-demand mismatch is also highlighted by these failed or 'sub-prime' production processes. Although labor disputes are highly visible in the manufacturing process, the loss of skilled labor has become one of the biggest challenges that the IC industry undergoes in HK (Ekanayake et al., 2020c). In order to withstand production-based SCV, resourcefulness is suggested to be the optimal solution (with the path significance of 9.181). Collaborative decision making is vital in this regard, where it is possible to generate accurate prefabricated components exclusive of errors. Zhong et al. (2017) suggested deploying the Internet of Things (IoT) enabled BIM platform in the IC supply chains to improve collaborative data interoperability.

Similarly, the industry is currently utilizing BIM-enabled platforms in their projects, targeting improved professional collaboration from manufacturing to assembly. These tools facilitate early design freeze and supply chain visibility, which enable more error-free designs. In addition, the systems, including enterprise resource planning, provide timely alerts to project stakeholders on resource shortages and buffers, which may reduce unnecessary queuing of resources or the prefabricated units themselves. Unnecessary queuing can have a high impact on compact sites in the city of HK. In addition, obtaining competitive prices from suppliers is critical (Lim et al., 2011) since the process enables selecting appropriate prefabrication manufacturers as most of the units are outsourced to HK from mainland China.

Nevertheless, outsourcing is beneficial, given the higher cost of skilled labor and the skilled labor scarcity in the industry. The quality assembly of IC units depends upon the caliber of the skilled labor and their motivation. Therefore, facilitating adequate site safety to avoid labor-related disputes is worth stating. The current practice of the public housing authority of HK provides a great example since they conduct quarterly safety audits of their contractors on IC projects and blacklist if under-performing. Therefore, the developed capability of improved safety is also essential in this respect in the IC projects in HK. As a result, increased resourcefulness enables more effective withstanding of production-based SCV in IC.

5.2 Dispersion (DIS) → Economic SCV (ESCV)

As the second steady path, shown in Fig.4., dispersion (DIS) with just one measurement item, namely distributed decision-making, substantially impacts on retarding economic SCV with the path significance of 3.222. Decentralization of critical decision-making power is very helpful in providing fast and appropriate recovery from disruption. Since IC supply chains are highly fragmented, on-site decision making should be undertaken by the site experts as in a factory. Therefore, economically feasible decisions on outsourcing and favourable decisions under industry/market pressure could be made and would adequately respond to the economic SCV. Risks of escalating project costs may substantially reduce due to quick but better-informed, hence sound decision-making in the materials flow control process (Zhai et al., 2019).

5.3 Resourcefulness (RES)→ Economic SCV (ESCV), Organizational SCV (OSCV) and Procedural SCV (PSCV)

Resourcefulness is also effective in dealing with the economic SCV (with the third-highest path significance of 2.733). This path is closely related to the disruptions due to the economic changes and affected by economic policy changes. A special feature of these disruptions is that their disruptive impact is acute, although they are not frequent. Price fluctuations impact resource scarcity, and outsourcing decisions are affected by exchange rate fluctuations in IC supply chains (Ekanayake et al., 2020c). Collaborative decision making is influential in this respect. Prefabricated components are almost impossible to modify after producing them, leading to tedious rework and cost overruns in the event of mistakes. Not being an exception, IC projects in HK also face risks of disruptions due to design, manufacture, and assembly problems (Li et al., 2011). As Wong, Hao and Ho (2003) suggested, having better control over manufacturing substantially reduces the chances of cost overruns. Tardiness in supply chain deliveries hampers the associated IC benefits (Mok et al., 2015), where 'buffer space hedging' is suggested to be effective (Zhai et al., 2019), which would also be included under the resourcefulness construct. Cybersecurity as a RES capacity is influential in avoiding information misuse through information systems and software to prevent rework from design configuration. Therefore, this should be considered as well, despite having an excellent information sharing platform to enhance supply chain collaboration. That is why a resourceful, collaborative approach is required in making all supply chain decisions to avoid disruptions due to economic SCV. Further, resourcefulness supports the other two vulnerability constructs of organizational and procedural. These constructs cover the specific SCV associated with IC in HK, such as transport disruptions and safety issues due to the handling of overweight and oversized prefabricated components, including transporting them from China to HK. Therefore, resourcefulness is highly influential in overcoming these identical and highly influential vulnerabilities to a greater extent.

[Insert Fig.4. here]

5.4 Capacity (CAP) → Production-based SCV (PBSCV)

CAP (capacity) development towards production-based SCV received the fifth-highest importance with a path significance of 2.452. Capacity construct covers the availability of resources for continuous supply chain operation. Having backup supply chain equipment, including machinery at the factory and on-site equipment such as cranes and hoists, is beneficial (Ekanayake et al., 2020d) to avoid supply-demand mismatch or shortages over time. Redundancy as a capacity measurement item facilitates quick recovery after disruption despite the failure of the entire system (Sheffi and Rice, 2005), hence being quite useful in any significant disruption, especially in supply chain breakdowns due to quality issues, supply shortages, and labour disputes. However, it is still questionable whether many firms' existing capacitiesd can provide redundancies to overcome disruptions and maintain continuity in IC supply chains in HK; hence alerting practitioners to the need for capacity improvements. Emergency response management (Irizarry et al., 2013) is another capacity measurement item that guarantees a speedy recovery from disruptions and is very important in the supply chain flow's continuity. Having a capable professional team for disruption management is necessitated since all these production-based disruptions are critical and depend largely upon human factors. Maintaining an effective communication strategy is highly influential in mitigating these SCV since IC supply chains in HK are fragmented (Ekanayake et al., 2020d). That is why several reputed construction companies have integrated the entire supply chain with BIM models by enhancing effective communication and accountability between the supply chain stakeholders. However, there is a way forward to realize resilient supply chains by inculcating these practices even in 'modular integrated construction' (MiC) or in design for manufacture and assembly (Ekanayake et al. 2020d) which are specific approaches in the IC sector.

5.5 Flexibility (FLE) → Economic SCV (ESCV)

Flexibility negatively impacts the economic SCV when targeting resilient supply chains in IC in HK with a path significance of 2.390. Under the flexibility construct, vertical integration is significantly advantageous and economically feasible over outsourcing prefabricated components. Since most IC contractors do not maintain their in-house prefabrication plants, the contractors are denied higher profit levels under the self-manufacturing decision (Han et al., 2017), necessitating vertical integration of the supply chain manufacture and assembly. Production postponement is also an economic decision that should be taken under economic and financial policy changes (Ekanayake et al., 2020d). Risk pooling and sharing is another substantial flexibility measurement item, necessitating effective public-private collaboration as a legitimate and useful risk-sharing mechanism in withstanding economic SCV in IC in HK. Since this has not been fully appreciated, leave alone implemented, the major benefits are yet to be realized.

Accordingly, this research highlights the need to reinforce the supply chain capability constructs of resourcefulness, capacity, dispersion, and flexibility by paying specific attention to production-based and economic SCV in realising resilient IC supply chains in HK. Industry practitioners and professionals may benefit from paying more attention to the appropriate application of this study's findings in their critical decision-making processes to develop improved implementation programs for effective disruption management. The computed PLS-SEM model in Fig. 4 is based on HK-IC practices but could also be used as a basis for other countries/ jurisdictions where IC is well-practised.

6. Contribution, Managerial Implications and Focused Recommendations

Advanced supply chain management strategies based on recent advances in SCR are widely adopted in today’s competitive economy. Their successful implementation has proved effective in handling unpredictable supply chain disruptions. The recent COVID 19 pandemic highlights the imperative for resilience to overcome such unpredictable disruptions. Therefore, achieving resilient supply chains is essential from the organizational level in any industry context. From this viewpoint, it has become necessary for the professionals involved in IC in HK to evaluate, check and compare SCC for improving SCR in IC while assessing their individual impacts on industry-specific SCV. Further, a sound awareness of significant SCC and SCV and their correlation can be critical in making decisions for adopting and applying SCC appropriately in practice. Hence, this study examines the crucial co-relational impact of SCC and SCV in IC supply chains under the umbrella of SCR.

The results and the model generated from this study are expected to be of great value to industry professionals, researchers, and policymakers who are seeking evidence-based quantitative justifications and explanations of the influence of SCC towards SCR in IC in HK. Hence, the key contribution of this study is towards improving current best practices. It is from developing a quantitative PLS-SEM model that explains how various types of SCC can help achieve SCR by effectively withstanding critical SCV in the IC sector. Industry practitioners could map these capabilities with the corresponding SCV and deploy SCC at suitable levels and in appropriate doses to withstand those corresponding SCV.

Fig. 5, which depicts an 'enablers-results framework' for achieving SCR of IC in HK, was thereby developed to provide more focused recommendations for improving current best practices of IC. Accordingly, SCC of resourcefulness, dispersion, capacity, and flexibility were remain highlighted as the enablers of SCR implementation. However, the support from the project management team, organizational policy and strategy and optimized resource utilization are essential to suitably mobilize these enablers to help achieve resilience targets. With these, the critical vulnerabilities of production-based, economic, organizational, and procedural SCV could be better managed. Indeed, the resilience capability of IC supply chains would be enhanced, thereby the IC project performance would be improved, and the overall industry performance could be boosted. Ultimately, this could contribute positively to the economic development of HK. Together with the developed PLS-SEM model, this 'enablers-results framework' could be tested and validated in future research. Also, these can be used as assessment tools of general practice and performance to highlight gaps in an organization's practices and performance while recommending action plans for further improvement.

[Insert Fig.5. here]

Theoretically, this study also contributes to the SCR and IC knowledge domains by initiating novel research approaches and proposing a model explaining how various SCV and SCC influence the development of resilient supply chains in IC. This further expands the existing SCR research domain by extending its potential applications in the construction sector. In addition, the research methods employed in this study and the model developed here can be used as useful references and platforms for other jurisdictions where IC is widely practised. Thereby, industry professionals may develop such impact analysis models as appropriate to their industry contexts by considering jurisdiction-specific supply chain dynamics. Ultimately, this research provides useful directions for the construction industry to develop resilient, value-enhanced and sustainable IC practices in general.

7. Conclusions, limitations, and ways forward

IC is a cleaner, greener, and leaner construction method that considerably contributes to global sustainable development. However, the associated SCV retard IC supply chains' performance and erode the espoused benefits of IC. In this regard, SCC should play a vital role to withstand the corresponding SCV so as to develop resilient supply chains. Although a few studies analyze the impact of SCC on SCV in manufacturing and service firms, there is no known research to date that includes similar impact analysis following an in-depth study of IC or even the broader construction industry. To address this imperative, after identifying this research gap and the potential value of bridging it, this study led to the development of a statistical PLS-SEM model to evaluate the impact of SCC on SCV in achieving resilient supply chains in IC in dense urban settings of HK. Relevant data were gathered through an expert survey involving seventy-six industry professionals possessing the required experience and knowledge on IC practices in HK. The results indicated that the supply chain capability construct of resourcefulness has the highest significant impact on withstanding production-based SCV, which is critical in this context.

Furthermore, six other significant paths were identified: resourcefulness related SCC can help to withstand economic, organizational and procedural SCV; capacity-related SCC can help to withstand production-based SCV; dispersion related SCC can help to withstand economic SCV; and flexibility related SCC can help to withstand economic SCV. Hence, resourcefulness, capacity, dispersion and flexibility were determined as the highly influential SCC in developing resilient supply chains in IC in HK. These results were included in a enablers-results framework and presented as what could be a managerial guide for industry practitioners. The results and the model generated from this study together with the enablers-results framework provide both theoretical and practical contributions to the

SCR and IC domains. This unsurprisingly benefits from drawing upon lessons learned, hence being enriched by combining relevant best practices from traditional construction and manufacturing.

However, there are some limitations of this study that are worth stating. Although the sample size of 76 is adequate to generate valid results, higher sample sizes with big data would enable even more robust outputs in future studies. Larger sample sizes may also allow other effective data analysis methods, such as generalized structured component analysis, which may improve research outcomes. Also, the factors studied in the manuscript may not be the only factors that affect the dependent variable. Indeed, there could be other potential factors, and their omission may potentially lead to unobserved heterogeneity and biases of the estimates in the model. Hence, the developed model should also be tested and verified using actual construction projects as the final step if taken as a 'Research and Development'(R&D) exercise. Since these findings are mainly interpreted within the HK context, similar studies for other geographical locations are suggested, after which the results could be compared and generalized. Besides, a factor-wise impact evaluation model of SCC considering the in-depth evaluation of separate measurement items (or "factors") could be developed, which will generate a robust and comprehensive output. It is also encouraged to update this model by incorporating upcoming, e.g., post-COVID19 industrial innovations and initiatives to feed into timely recommendations.

Meanwhile, the results from this study are by themselves useful and rigorously obtained. They can help upgrade current IC practices to a level of reasonable resilience, thereby realizing the main objective of value-enhanced, cleaner, and sustainable construction performance. In conclusion, the unprecedented supply chain disruptions caused by the global COVID19 pandemic, albeit emerging after the data collection and analysis for this study, showed how crucial it is to develop a suite of capabilities that can cope with even previously unimagined specifics, even if within the scope of the vulnerabilities identified and highlighted in this research.

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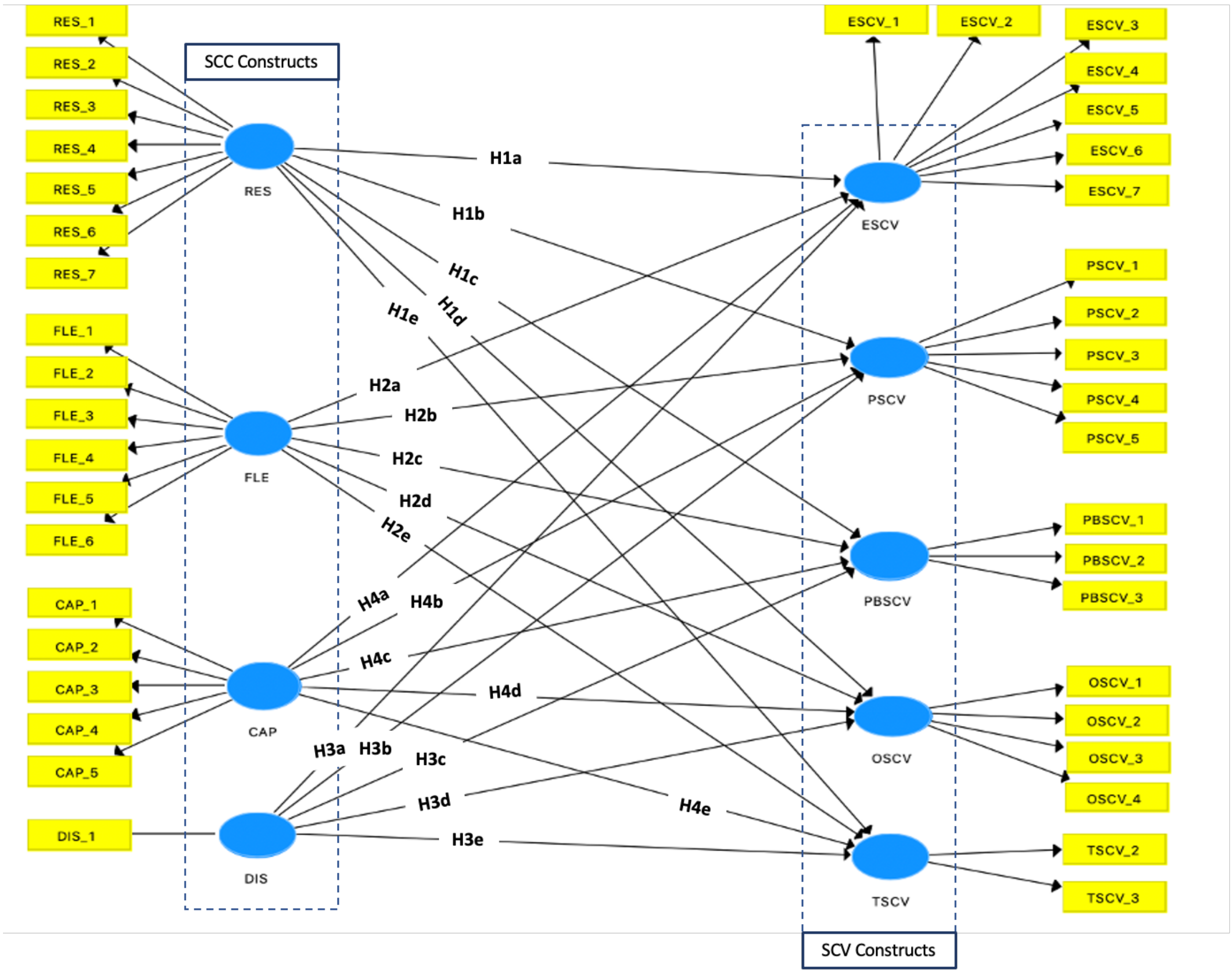
Supply Chain Capabilities (SCC)
Extracted from Ekanayake et al. (2020d)

SCC Construct	Code	Measurement Items
Resourcefulness	RES1	Personnel security
	RES2	Collaborative information exchange & decision making
	RES3	Collaborative forecasting
	RES4	Cyber-security
	RES5	Obtain more competitive price from suppliers and subcontractors
	RES6	Multiple sources/suppliers
	RES7	Maintaining buffer time
Flexibility	FLE1	Vertical integration
	FLE2	Production postponement
	FLE3	Alternate distribution channels/multimodal transportation
	FLE4	Modular product design
	FLE5	Multiple uses
	FLE6	Risk pooling/sharing
Capacity	CAP1	Backup equipment facilities
	CAP2	Redundancy
	CAP3	Consequence mitigation
	CAP4	Effective communications strategy
	CAP5	Professional response team
Adaptability	ADA1	Strong reputation for quality
	ADA2	Lead time reduction
	ADA3	Faster delivery
	ADA4	Close and healthy client-contractor relationships
	ADA5	Fast rerouting of requirements
Efficiency	EFF1	Failure prevention
	EFF2	Avoid variations/rework
	EFF3	Higher labour productivity
	EFF4	Waste elimination
	EFF5	Learning from experience
Financial Strength	FIS1	Good price margin
	FIS2	Portfolio diversification
	FIS3	Financial reserves and funds
	FIS4	Good insurance coverage
Visibility	VIS1	Efficient IT system & information exchange
	VIS2	Business intelligence gathering
	VIS3	Products, assets, people visibility
Anticipation	ANT1	Deploying tracking and tracing tools
	ANT2	Monitoring early warning signals
	ANT3	Alternative innovative technology development
	ANT4	Quality control
	ANT5	Cross training/intensive training
Dispersion	DIS1	Distributed decision making

Supply Chain Vulnerabilities (SCV)
Extracted from Ekanayake et al. (2020c)

SCV Construct	Code	Measurement Items
Economic SCV	ESCV1	Exchange rate fluctuations
	ESCV2	Price fluctuations
	ESCV3	Liability claims
	ESCV4	Cost overrun
	ESCV5	Industry/market pressures
	ESCV6	Information misuse
	ESCV7	Economic policy changes
Technological SCV	TSCV1	Technology failure
	TSCV2	IT system failure
	TSCV3	Inadequate IT systems
	TSCV4	Information loss
	TSCV5	Variations/rework
Procedural SCV	PSCV1	Safety issues
	PSCV2	Implication of new laws/regulation
	PSCV3	Systems/machines breakdown
	PSCV4	Transport disruptions including port stoppages
	PSCV5	Physical damage to the buildings/accidents
Organizational SCV	OSCV1	Communication breakdown/issues
	OSCV2	Loss of skilled workforce
	OSCV3	Disruptions due to outsourcing
	OSCV4	Inadequate supplier selection
Production-based SCV	PBSCV1	Quality loss
	PBSCV2	Supply-demand mismatch/shortages
	PBSCV3	Labour strikes/disputes

Fig.1. The research framework of the study



SCC– Supply Chain Capabilities, SCV – Supply Chain Vulnerabilities, RES – Resourcefulness, FLE – Flexibility, CAP– Capacity, DIS – Dispersion, ESCV – Economic SCV, PSCV – Procedural SCV, PBSCV – Production-based SCV, OSCV – Organizational SCV, TSCV – Technological SCV

Fig. 2. Model of Study Hypotheses

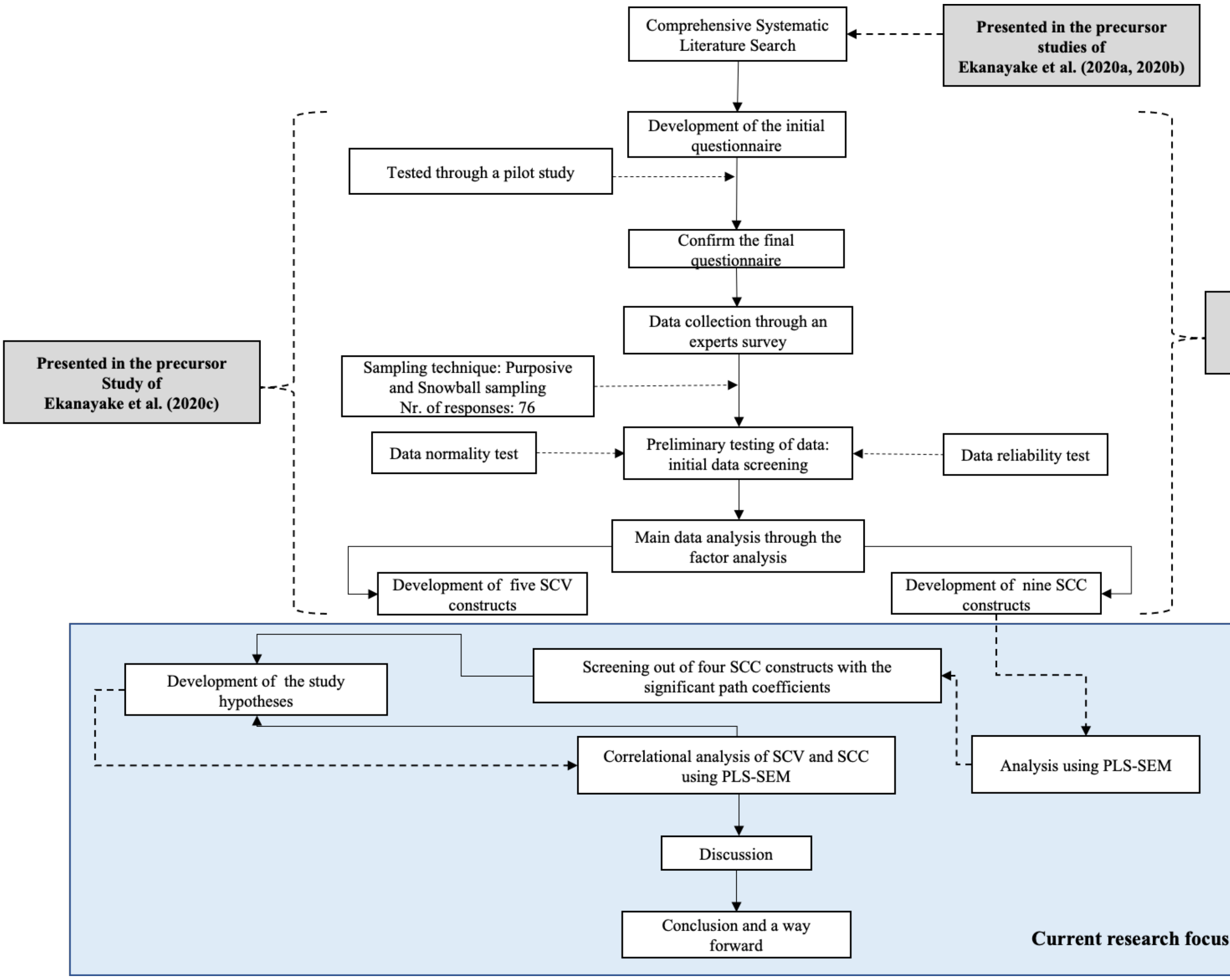


Fig. 3. Research methods used and flow of this study

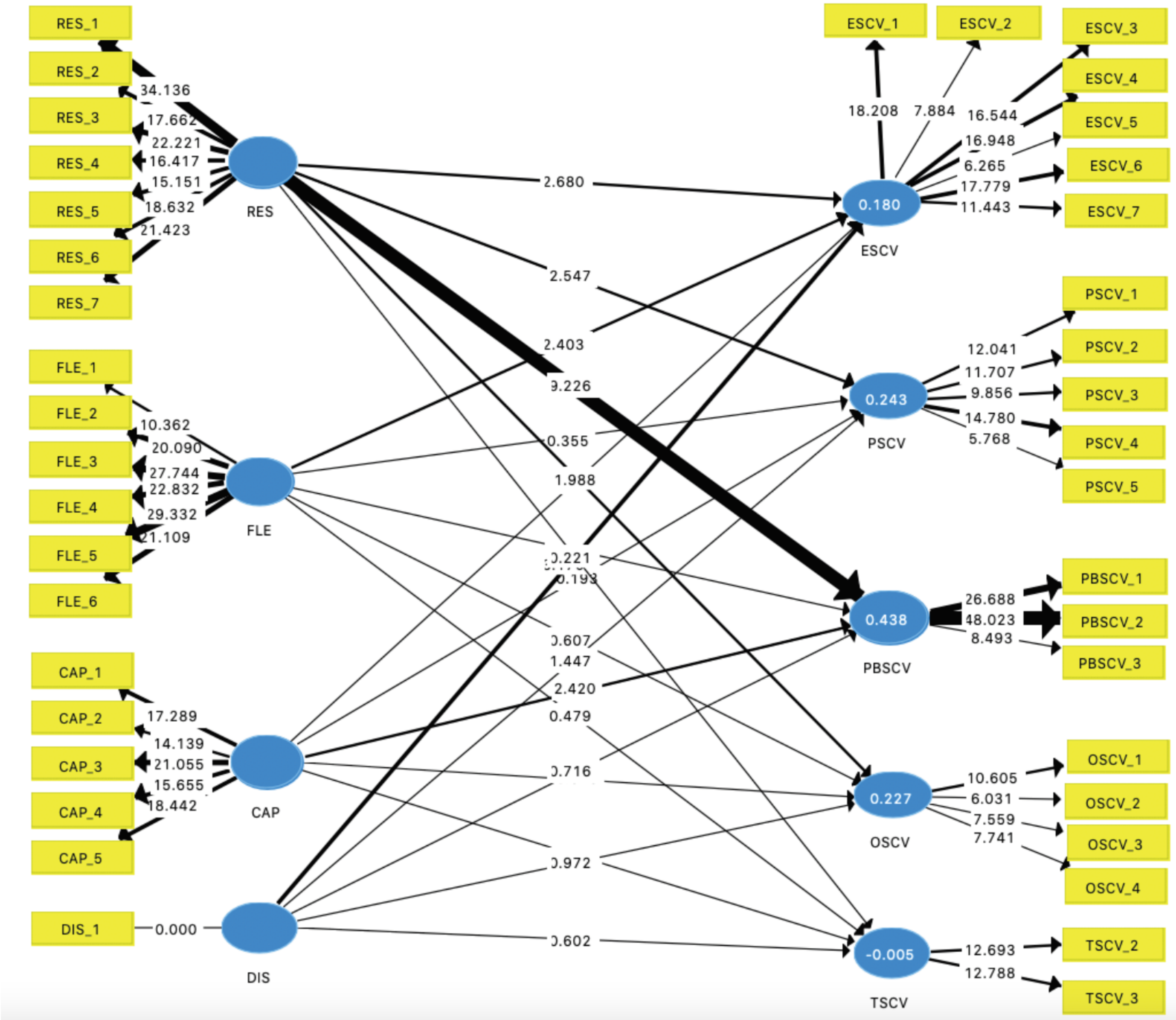


Fig.4. PLS-SEM model of the impact of SCC on withstanding SCV in achieving SCR of IC in HK

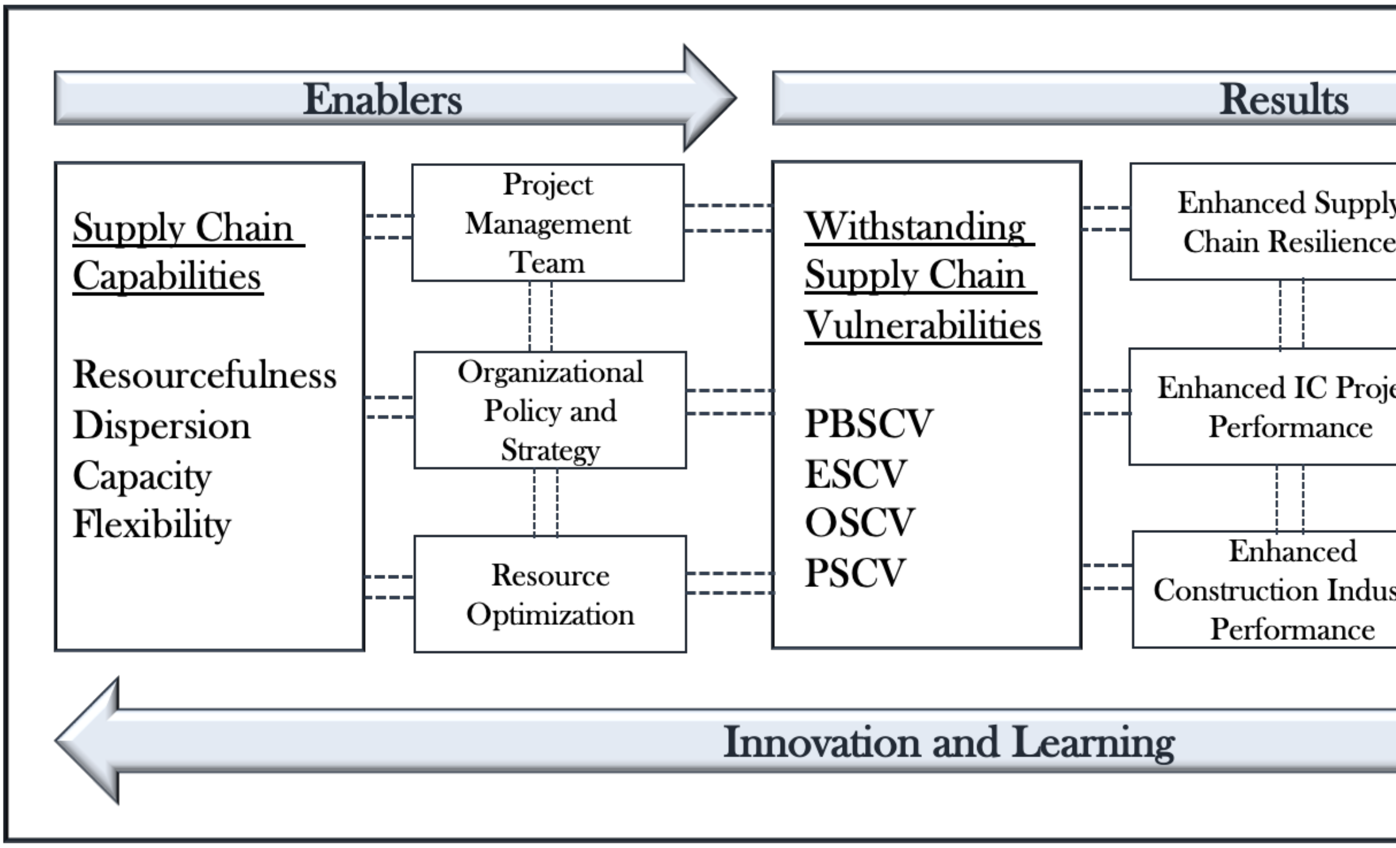


Fig.5. Enablers-results framework for achieving SCR of IC in HK

Table 1: Profile of the respondents

Category	Sub-category	Frequency	Relative frequency
Professional affiliation	Public Sector	23	30.3
	Private Sector	42	55.3
	Both	11	14.4
	Total	76	100.0
Professional experience	1-5 Years	1	1.3
	6-10 Years	18	23.7
	11-20 Years	23	30.3
	Above 20 Years	33	44.7
	Total	76	100.0
Position hold/held in organisation	Director	17	22.3
	Senior Manager	27	35.5
	Manager	16	21.1
	Other Staff	16	21.1
	Total	76	100.0

Table 2: Measurement validity of constructs

Latent Variables	Code	CA	rho_A	CR	AVE
Supply Chain Vulnerability Constructs					
Economic Supply Chain Vulnerabilities	ESCV	0.892	0.912	0.915	0.606
Organisational Supply Chain Vulnerabilities	OSCV	0.712	0.710	0.821	0.535
Production-based Supply Chain Vulnerabilities	PBSCV	0.804	0.846	0.883	0.717
Procedural Supply Chain Vulnerabilities	PSCV	0.869	0.886	0.905	0.657
Technological Supply Chain Vulnerabilities	TSCV	0.906	0.908	0.955	0.914
Supply Chain Capability Constructs					
Capacity	CAP	0.879	0.888	0.911	0.673
Dispersion	DIS	1.000	1.000	1.000	1.000
Flexibility	FLE	0.919	0.931	0.936	0.711
Resourcefulness	RES	0.918	0.924	0.934	0.670

Note: CA represents Cronbach's Alpha; AVE represents Alpha Average Variance Extracted; CR represents Composite Reliability.

Table 3: Discriminant validity of constructs

	CAP	DIS	ESCV	FLE	OSCV	PBSCV	PSCV	RES	TSCV
CAP	**0.820**								
DIS	0.439	**1.000**							
ESCV	0.134	0.304	**0.778**						
FLE	0.744	0.360	0.217	**0.843**					
OSCV	0.409	0.104	0.272	0.430	**0.731**				
PBSCV	0.133	0.055	0.037	0.255	0.620	**0.847**			
PSCV	0.402	0.345	0.408	0.414	0.558	0.412	**0.811**		
RES	0.649	0.345	0.070	0.694	0.484	0.594	0.494	**0.818**	
TSCV	0.195	0.151	0.386	0.103	0.165	0.186	0.046	0.131	**0.956**

The bold diagonal values are the square root of average variance extracted of each construct, while the other values are the correlations amongst constructs.

Table 4: Evaluation of structural model

Paths	(O)	(M)	(STDEV)	(|O/STDEV|)	P values	Inference
CAP→ESCV	0.043	0.046	0.195	0.218	0.827	Not Supported
CAP →OSCV	0.145	0.158	0.178	0.818	0.413	Not Supported
CAP →PBSCV	**0.372**	**0.365**	**0.154**	**2.420**	**0.016***	**Supported**
CAP →PSCV	0.035	0.051	0.184	0.193	0.847	Not Supported
CAP →TSCV	0.221	0.185	0.230	0.964	0.335	Not Supported
DIS→ESCV	**0.319**	**0.317**	**0.101**	**3.170**	**0.002****	**Supported**
DIS →OSCV	0.125	0.143	0.129	0.972	0.331	Not Supported
DIS →PBSCV	0.068	0.079	0.095	0.716	0.474	Not Supported
DIS →PSCV	0.179	0.180	0.124	1.447	0.148	Not Supported
DIS →TSCV	0.083	0.097	0.138	0.602	0.547	Not Supported
FLE →ESCV	**0.460**	**0.477**	**0.192**	**2.403**	**0.016***	**Supported**
FLE →OSCV	0.127	0.134	0.210	0.607	0.544	Not Supported
FLE →PBSCV	0.076	0.077	0.168	0.450	0.652	Not Supported
FLE →PSCV	0.074	0.051	0.209	0.355	0.722	Not Supported
FLE →TSCV	0.122	0.092	0.254	0.479	0.632	Not Supported
RES→ESCV	**0.472**	**0.483**	**0.176**	**2.680**	**0.007****	**Supported**

RES →OSCV	**0.345**	**0.348**	**0.174**	**1.988**	**0.047***	**Supported**
RES →PBSCV	**0.911**	**0.921**	**0.099**	**9.226**	**0.000****	**Supported**
RES →PSCV	**0.358**	**0.374**	**0.141**	**2.547**	**0.011***	**Supported**
RES →TSCV	0.043	0.044	0.194	0.221	0.825	Not Supported

Note:
(O) = Original Sample; (M) = Sample Mean; (STDEV) =Standard Deviation;
(|O/STDEV|) = t statistics
The bold texts represent the significant paths.
*The path coefficient is significant at $p < 0.05$
** The path coefficient is significant at $p < 0.01$