

Supply chain information integration, supply chain innovativeness and supply chain resilience among manufacturing firms in a developing context

Influence of
SCII on SCI and
SCRE

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Abstract

Purpose – The purpose of this study is to empirically explore the influence of supply chain information integration (SCII) on supply chain innovativeness (SCI) and supply chain resilience (SCRE).

Design/methodology/approach – Data from 403 manufacturing companies in Uganda were analyzed using Analysis of Moments of Structures version 27. Unmeasured common latent factors were used to minimize the bias of common methods.

Findings – SCII, SCI and SCRE have significant positive relationships. About 41% of SCII and SCRE are partially mediated by SCI.

Research limitations/implications – Considering variations in perception of SCRE, the cross-sectional nature of the study limits generalizability and transferability. Experiments and interviews are recommended to explore differences between firms in SCRE.

Practical implications – SCII and SCI capabilities buffer a firm's SCRE.

Originality/value – This study establishes SCI as a mediator between SCII and SCRE by studying manufacturing firms in a developing country context.

Keywords Supply chain innovativeness, Supply chain information integration, Supply chain resilience

Paper type Research paper

1. Introduction

The environment in which firms operate today is rapidly changing, complex and turbulent. With global interdependence, organizations use interconnected supply chains to deliver goods and services to clients (Munir *et al.*, 2020). With increased competition, firms have developed sophisticated operational strategies, including lean manufacturing and global sourcing (Rashad and Nedelko, 2020). Due to prevailing global interconnections, firms are



increasingly vulnerable to a range of supply chain threats (Tukamuhabwa *et al.*, 2017). The uncertainties like coronavirus disease 2019 (Covid-19) outbreak in China in 2019, and the conflict between Ukraine and Russia led to supply chain disruptions worldwide (Balbaa *et al.*, 2022). Manufacturing firms are better prepared to cope with disturbances in their supply chains by developing resilient supply chains. Continuous disruption to firms' supply chains is inevitable due to unforeseen events (Chowdhury and Quaddus, 2016). Hosseini *et al.* (2019) identify supply chain resilience (SCRE) as a network's ability to withstand, adapt to and recover from disruptions. Against this background, SCRE research is still concern for both practitioners and academicians (Vishnu *et al.*, 2019).

There are still gaps in research regarding SCRE (e.g. Negri *et al.*, 2021; Golgeci and Kuivalainen, 2020). Recently, studies found SCRE in developed countries (Tukamuhabwa *et al.*, 2017), the use of blockchain (Chowdhury *et al.*, 2022), the importance of organizational flexibility (Dubey *et al.*, 2019), supply chain risk management (Ozdemir *et al.*, 2022), social capital, absorptive capacity (Golgeci and Kuivalainen, 2020), relational practices, complexity of networks (Chowdhury *et al.*, 2019), and network characteristics and risk propagation (Li *et al.*, 2020). Other researchers have suggested building a resilient supply chain by leveraging risky decision-making processes (Vanpoucke and Ellis, 2019, 2020) and Xu *et al.*, 2020).

In these studies, there is a substantial gap in how SCII impacts SCRE as well as SCI as a mediator of such a relationship; however, literature indicates such a relationship exists (Xu *et al.*, 2020). Most recent empirical studies were conducted in industrialized countries (Li and Zobel, 2020; Xu *et al.*, 2020). A significant portion of global supply chains is driven by developing countries. Additionally, global interconnectedness and interdependence could cause disruptions in supply chains in developing countries. In addition, according to Li and Zobel (2020), disruptions in a few firms can spread to neighboring firms. Furthermore, threats are more prevalent in developing countries than in more mature industrial economies (Tukamuhabwa *et al.*, 2015). Resilience theory postulates that it is not the nature of adversity that is most important, but how we deal with it. When we face adversity, misfortune or frustration, resilience helps us bounce back (Garmezy, 1974). The capacity of a dynamic system to adapt successfully is important in the manufacturing sector (Masten, 2014; Southwick *et al.*, 2014). This study is anchored on the dynamic capability theory to explain the required capabilities to survive in times of uncertainty. The cultural, political and territorial contexts of Uganda, where supply chains are embedded, contribute to unusual threats to SCRE (Tukamuhabwa *et al.*, 2017).

Most manufacturing firms in Uganda are micro, small and medium-sized enterprises, which face SCRE threats. This results in chronic disruptions such as political instability, unfair competition, weak legal systems, corruption, dishonest suppliers, customers and employees (Tukamuhabwa *et al.*, 2017). Such threats may be less obvious in developed economies (Deshmukh and Haleem, 2020). In 2011 and 2021, presidential campaigns in Uganda and Kenya disrupted business in Uganda and disrupted fuel and raw material supply chains. Supply chain disruptions may not be adequately prepared by manufacturers (Katsaliaki *et al.*, 2021).

In Uganda, many supply chain risks lead to late deliveries, poor quality products, delivery failures or complete supply chain failures, and most fail within the first five years of their establishment (Tukamuhabwa *et al.*, 2017), which can be interpreted, in part, as a sign of an insufficient SCRE. SCRE relationship to its antecedents is controversial. Other scholars argue that it can be nonlinear and have negative effects (Fan and Stevenson, 2019), while others contend it is positive and linear (Golgeci and Kuivalainen, 2020). Based on dynamic capability theory, we examine how SCII and SCI influence SCRE. This study addresses the following question (RQ1): *Does manufacturing firm SCI influence SCII and SCRE?*

According to recent systematic literature reviews, more empirical studies are needed on SCRE, especially in developing countries (Ali *et al.*, 2017; Ali and Gölgeci, 2019; Rha, 2020). Researchers have shown that companies facing risks should learn ways to improve resilience by working with both internal and external stakeholders (Shafi *et al.*, 2020). Data from 430 manufacturing firms were analyzed using structural equation modeling (SEM). Results show that supply chain information integration (SCII) and supply chain innovativeness (SCI) have a positive significant relationship, with SCRE and SCI partially mediating this relationship. In the remaining sections, we present a literature review and hypotheses development; methods employed; results of the study; discussion, conclusion and implications; and references.

2. Literature review

2.1 Theoretical underpinning

Dynamic capabilities theory underpins the study. Dynamic capabilities theory explains why some firms perform better than others in a constantly changing environment and how they use different capabilities to maintain a competitive position (Teece *et al.*, 1997; Teece, 2020). Firms need to be able to respond quickly, innovate rapidly, and coordinate and deploy their internal and external capabilities effectively to address SCRE challenges. An organization's management plays a key role in adapting, integrating and configuring its internal and external skills, resources and functional competencies to changing environments involving uncertainty (Haarhaus and Liening, 2020). Dynamic capability theory has been used to explain supply chain risk in uncertain environments (Um and Han, 2020). By integrating information, reconfiguring resources and innovating across the chain, firms can proactively and reactively bounce back after a disruption in the supply chain (Köhler *et al.*, 2022). SCII and SCI are considered necessary dynamic capabilities for predicting SCRE in manufacturing firms.

2.2 SCRE

According to Kopanaki (2022), SCRE enables the supply chain to prepare for, respond to and recover from disruptions, regaining its previous level, or preferably, even improving it. A number of empirical and case studies have examined strategies aimed at improving SCRE (Golgeci and Kuivalainen, 2020), but very few have examined the antecedents (Tukamuhabwa *et al.*, 2017). SCREs are generally built using a variety of strategies. However, previous scholars have noted ambiguity and complexity in their relationships to SCRE. Some strategies may reinforce or contradict one another, and some may even subsume others, according to Tukamuhabwa *et al.* (2017). According to Tukamuhabwa *et al.* (2017), implementing some strategies may lead to unintended consequences that inhibit resilience. Several scholars have proposed antecedents or strategies to SCRE, while others have explored its dimensions. Rather than antecedents, researchers view flexibility, redundancy, visibility, collaboration and agility as SCRE dimensions. More research is needed to understand how SCRE relates to its antecedents.

2.3 SCI

SCI is defined by an organization's ability to continuously capture value for the entire supply chain by using the collective expertise, knowledge, skills, and resources of its supply chain members (Iddris, 2016). This can be updated processes, products, services, or administrative systems. In order to create customer value, innovation requires the exchange of complementary resources and expertise between firms. SCI can be operationalized as product, market and process innovativeness (Zastempowski, 2022). Innovation can be measured by the perceived novelty, originality and uniqueness of a product, whereas market

innovation can be measured by the innovativeness of a company's approach to entering and exploiting the targeted market with cutting-edge products (Borowski, 2021). Cuevas-Vargas *et al.*, (2022a, b) and Kahn *et al.* (2022) define process innovativeness as the ability to exploit technological advances.

2.4 SCII

Tarigan *et al.* (2021) define SCII as the amount of information flowing in a network. Collaboration and information sharing are key components of SCII (Cai *et al.*, 2010). Information is shared via phone calls, meetings and electronic channels (Yang *et al.*, 2021). Information can enhance (SCRE), such as supply chain planning and just-in-time production (Zhang *et al.*, 2020). Consumer research, material and stock replenishment, capital performance, growth strategy, overhead structure, capacity planning and technology are shared (Mofokeng and Chinomona, 2019). Moreover, collaborative planning improves resource utilization (labor, equipment, etc.) and production flow, facilitating cross-functional coordination and resilience to disruptions (Zhang *et al.*, 2020). The development of an electronic supply chain infrastructure facilitates timely, accurate and standardized data exchange between internal and external functions (Zhang *et al.*, 2020). A flexible firm can cope with rapid market changes (Wang *et al.*, 2018, 2021).

2.5 SCII and SCRE

By sharing information and planning collaboratively, supply chains can become resilient (Siagian *et al.*, 2021). By collaborating with others, companies gain both internal and external knowledge (Geissdoerfer *et al.*, 2018). In a study of 182 manufacturing firms in Pakistan (Piprani *et al.*, 2020), collaboration with internal and third-party stakeholders led to enhanced SCRE. According to Piprani *et al.* (2020), external integration impacts SCRE. For example, Prajogo and Olhager (2012) based on data from 232 Australian companies and suggest that early supplier integration improves resilience. Additionally, Saeed *et al.* (2022) and Gruzauskas and Vilkas (2017) review of scientific literature found collaborative capabilities affect SCRE. A resilient collaborative group requires shared information and strategic plans (Banomyong, 2018). In their study of 84 Chinese listed food companies, Yu *et al.* (2018) demonstrated that internal and external information can increase supply chain flexibility. SCRE is strengthened by the integration of the different supply chain tier members' business processes (Bae *et al.*, 2023), not only by sharing demand and need information, but also by collaborating on long-term goals and planning (Christopher and Peck, 2004), which can be used to establish key parameters for the prediction and prevention of potential risks (Paul *et al.*, 2021). However, measuring the SCRE of manufacturing enterprises and building a practical resilience early warning system requires further study (Qi *et al.*, 2022). Developing countries like Uganda have not developed manufacturing resilience strategies due to limited human, technological and systems capabilities (Tukamuhabwa *et al.*, 2017). In this sense, integrated risk management capability enables an enhanced response to omnipresent supply chain disruptions (Belhadia *et al.*, 2021). This leads to the following hypothesis:

H1. SCII positively relates with SCRE.

2.6 SCII and SCI

Siagian *et al.* (2021) and Medase and Abdul-Basit (2020) recognize SCII as an imperative enabler of SCI. SCII is collaborative planning and information sharing, according to Cai *et al.* (2010). Siagian *et al.* (2021) argue that SCII enhances a firm's ability to share product information and production plans. Medase and Abdul-Basit (2020) contend that SCII is an essential component of innovation propensity. Exploring the surrounding environment

enhances firm capabilities by leveraging external knowledge. With SCII, more parties can access external knowledge within manufacturing firms. By exchanging external knowledge, focal firms can exchange broader and richer information on environmental changes (Wei *et al.*, 2020), complementing their lack of access to foreign joint innovation. Collaboration with other companies is also facilitated by external knowledge (Akn Ateş *et al.*, 2022).

Ehls *et al.* (2020) highlight how external knowledge can foster innovation and creative product ideas. In their studies, Lintukangas *et al.* (2019) argue that firms can achieve more innovative products with more suppliers. The result is a more competitive supply chain through innovative thinking (Farhana and Bimenyimana, 2015). Chen (2019) argues that supply chain information integration (SCII) can lead to innovation, since forming joint partnerships can lead to product, service and market innovation. Despite all the above findings, no study analyzed the direct relationship between SCII and SCI, while Mandal *et al.* (2016) and Mandal and Sarathy (2018) remained conceptual. Based on the literature, we extrapolated the assumed relationship. As a result, this study hypothesizes the following:

H2. SCII positively relates with SCI

2.7 SCI and SCRE

SCI is widely considered an essential and desirable capability for SCRE. Researchers have shown that firms' ability to innovate enables them to respond proactive to disruptions in their supply chains (Akn Ateş *et al.*, 2022; Al-Hakimi *et al.*, 2021; Parast, 2020). Research by Sabahi and Parast (2020) suggests investing in innovation can help companies manage uncertainty. As Al-Hakimi and Borade (2020) point out, innovation addresses lagged demand for original products. SCI promotes operational continuity and agility toward customer demands (Sunil, 2019). In a study by Siagian *et al.* (2021), innovation systems improve SCRE. Firms that persist in innovation during turbulent times accumulate knowledge to handle them, Kalyar *et al.* (2020). Innovative firms engage their employees and turn their ideas into best practices that impact SCRE (Zavala-Alcívar *et al.*, 2020a). In similar fashion, supply chain product innovation improves firm performance (Akn Ateş *et al.*, 2022). As such, innovation and auxiliary innovation are regarded as an underlying culture of resilience (Lv *et al.*, 2018). Innovativeness may lead to SCRE, according to literature. To reach this conclusion, Akgün and Keskin (2014) studied organizational resilience and one component of supply chain and product innovativeness among 112 firms in Turkey. Recent research on SCRE in developing countries has examined the resilience of supply chains to product counterfeiters (Stevenson and Busby, 2015), and this can be a particularly acute problem (Chika *et al.*, 2011). In this study, we argue that SCI influences SCRE.

H3. SCI is positively related with SCRE.

2.8 Mediating role SCI between SCII and SCRE

In SCII-SCRE, SCI may mediate. SCII indirectly influences SCRE through SCI. As Medeiros *et al.* (2020) suggest, dynamic capabilities integrate, reconfigure, gain and release resources in response to uncertainty. Markets emerge, collide, split, evolve and die because of dynamic capabilities (Medeiros *et al.*, 2020). Consequently, SCII may have little impact on SCRE unless the supply chain innovation is activated. Sabahi and Parast (2020) suggest that SCI may act as a mediator between selected antecedents and SCRE. Using the Indonesian statistical center agency's database, Siagian *et al.* (2021) found that supply chain integration impacts innovation, resulting in SCRE. In addition, Spieske and Birkel (2021), Kochan and Nowicki (2018) conducted systematic literature reviews on SCRE and found that innovation can improve knowledge sharing, agility and flexibility within a firm, which significantly enhances resilience. As a result, supply chains that collaborate and share information with

other supply chains will be more resilient in ever-changing environments (Negri *et al.*, 2021). Additionally, cooperation could result in new dangers, such as the sharing of sensitive data (Jüttner and Maklan, 2011), and horizontal cooperation between suppliers could raise supply chain risk through collusion (Choi and Krause, 2006). Finally, according to Jüttner and Maklan (2011), enterprises' flexibility through multiple sourcing and the opening of numerous branches may result in liquidity risk among manufacturing firms in developing countries. We, therefore, hypothesize the following:

H4. SCI mediates the relationship between SCII and SCRE.

2.9 Control variables

A review of previous scholarly work led us to include three control variables. These variables influence exogenous and endogenous variables causing unwanted variance in SCRE R2. According to Cao and Zhang (2011), smaller companies lack the resources to implement SCRE, whereas Wagner and Neshat (2012) argue that established firms are more vulnerable. The number of employees was used to estimate firm size (Gligor *et al.*, 2015). Gligor *et al.* (2015) report that firm age affects SCRE implementation. Both firms' ability to innovate (SCI) and their resilience (SCRE) can be affected by the type of firm they belong to. The above hypotheses are based on the theoretical model in Figure 1.

3. Methods

3.1 Data collection, population, sample size and sampling design

The study employed a quantitative cross-sectional survey, to collect data from 403 out of 2,292 manufacturing firms located in the industrialized areas of Kampala, Mukono, Wakiso and Jinja. The firms use agricultural produce as inputs/raw materials in manufacturing, where the concept of SCRE is relevant, using a self-administered survey (Schuberth *et al.*, 2020) using a questionnaire ranging from 1 for strongly disagreeing to 7 for strongly agreeing.

Stratified simple random sampling was used without replacement, to select 430 firms based on what they produce. Basing on targeted sample size, we computed the required number of firms from each stratum on which we applied simple random sampling because all firms in the same strata had the same characteristics. To obtain the number of firms to participate in the study from each stratum, the names of the firms were listed and allocated a number in each stratum. After, the numbers were selected randomly and each number selected was removed from the population to avoid duplication. Finally, the names matching the numbers constituted the sample units/frame. The sample frame was used to distribute the questionnaires to the human resources (HR) department of each firm after securing participation acceptance. The HR manager distributed the questionnaire to respondents (three responses from either; firm owners, operations/production managers, procurement

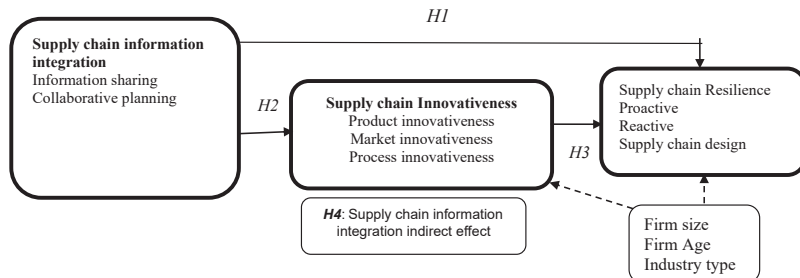


Figure 1. Hypothesized model

managers and logistics/supply chain managers as they were considered to be knowledgeable in supply chain-related operations. But as well as increasing reliability and validity of response), accompanied by a cover letter explaining the purpose of the study (safeguarding respondents' anonymity), while requesting respondents to spare 30–60 min to respond to the study items that were tapping the practices of SCRE and its antecedents. The adequate time for filling out the questionnaires was between 1 and 2 weeks based on convenience. After filling, the respondent returned the completed survey instrument to the HR, who notified us to pick the questionnaires enclosed in an envelope.

3.2 Instrument development and measurement

The instrument was developed based on the perception of the respondents in the manufacturing firms. SCII is measured by information sharing and collaborative planning (Cai *et al.*, 2010; Katsaliaki *et al.*, 2022). SCI is measured by market, process and product innovation (Zastempowski, 2022), while, SCRE is measured in terms of proactiveness, reactivity and supply chain design (Chowdhury and Quaddus, 2016). As a result of previous studies, we included three control variables in our conceptual model: organization size, firm age and industry type. Based on the number of employees (Gligor *et al.*, 2015) and Srinivasan and Swink (2018) calculate firm age as the number of years since the manufacturing firm was founded. Using a logarithmic formula, we measured the organization categories based on the nature of manufacturing.

3.3 Measurement validation

Cronbach's alpha and composite reliability cut-off values of 0.7 were suggested by Hair *et al.* (2017) for both observed and unobserved variables, indicating instrument internal consistency. Following that, exploratory and confirmatory factor analyses were conducted. To measure sampling adequacy and suitability before Exploratory Factor Analysis (EFA), Kaiser–Meyer–Olkin (KMO) and Bartlett's tests of sphericity were used (Watkins, 2018). The KMO value exceeded 0.7, and Bartlett's sphericity test was significant at the 0.000 level, confirming sampling suitability and adequacy for EFA (Li *et al.*, 2020) using a Vari-Max rotated component matrix. An Average Variance Extracted (AVE) of >0.5 and a total variance explained >50% were considered to be indicators of convergence validity. The total variances for all study variables exceeded 50% (three, and two factors explained 70.57%, 71.34% and 73.08% variance for SCRE, SCII and SCI, respectively). Based on the AVE values of all study constructs, we conclude the instrument tapped existing practices of SCII, SCI and SCRE in manufacturing. To further confirm reliability and validity of each study variable, we run confirmation factor analysis. The normed fit indices were >0.90, indicating reliability, while item loadings exceeded 0.5 to indicate convergent validity (Hair *et al.*, 2017). Results showed that the square root of the AVEs for each study variable exceeds the correlation between variables, which indicates that separate independent variables contribute to SCRE (Sahoo, 2019). Finally, the measurement model presented in Figures 2–4 showed that all fit indices conformed to construct validity (Yaşlıoğlu and Yaşlıoğlu, 2020; Hair *et al.*, 2010).

3.4 Nonresponse bias test

A Levene's test of homogeneity was conducted to assess for non-response bias by comparing early and late responses. Lohr *et al.* (2016) say Levene's statistics should not be significant if responses are obtained at different intervals. Results in Table 1 indicate that there was no statistically significant difference between the waves using Levene's test, indicating that non-response bias is not present.

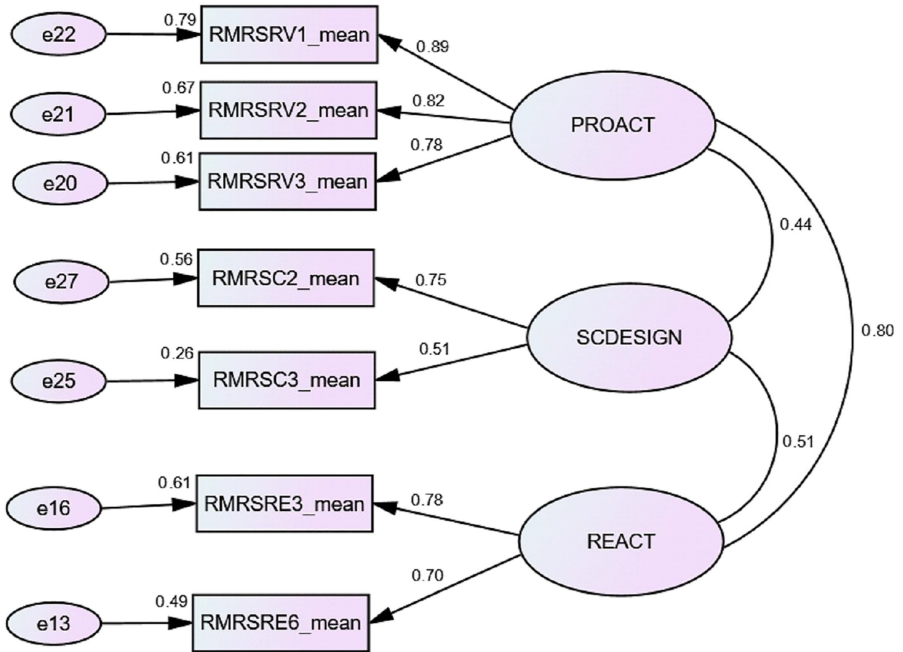


Figure 2.
SCRE
measurement model

Note(s): CMIN = 18.144; DF = 11; $P = 0.078$; CMIN/DF = 1.649; GFI = 0.987; AGFI = 0.967; NFI = 0.983; RFI = 0.968; IFI = 0.993; TLI = 0.987; CFI = 0.993; RMSEA = 0.040; PLCOSE = 0.653

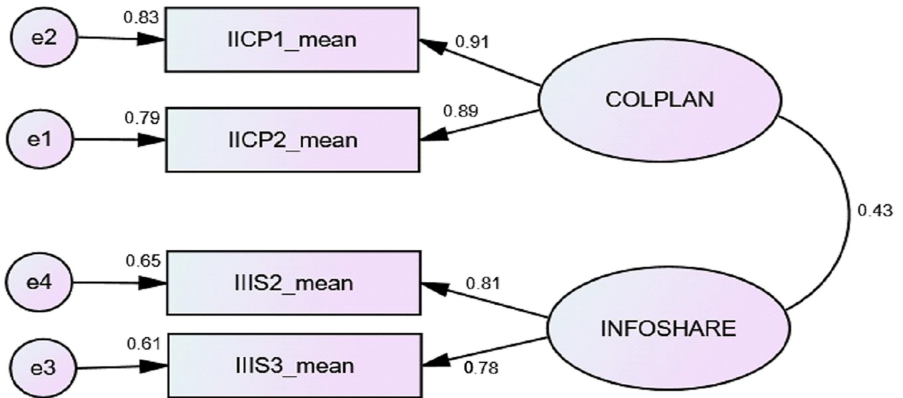
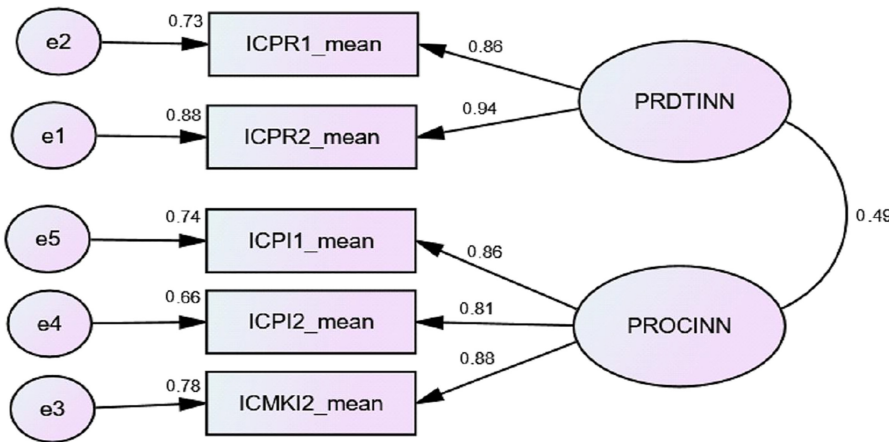


Figure 3.
SCII
measurement model

Note(s): CMIN = 2.023; DF = 1; $P = 0.155$; CMIN/DF = 2.023; GFI = 0.999; AGFI = 0.975; NFI = 0.997; RFI = 0.982; IFI = 0.999; TLI = 0.991; CFI = 0.999; RMSEA = 0.050; PLCOSE = 0.345



Note(s): CMIN = 9.220; DF = 4; $P = 0.056$; CMIN/DF = 2.305; GFI = 0.991; AGFI = 0.965; NFI = 0.992; RFI = 0.981; IFI = 0.996; TLI = 0.989; CFI = 0.996; RMSEA = 0.057; PLCOSE = 0.339

Figure 4. SCI measurement model

Study variables	Levene's statistic	df1	df2	Sig
SCII	2.146	3	400	0.097
SCI	1.477	3	400	0.223
SCORE	1.724	3	400	0.165

Table 1. Test of homogeneity of variances

3.5 Common method bias (CMB)

An ante remedy and a post-hoc test were used to control for common method bias (Kock *et al.*, 2021; Fuller *et al.*, 2016). By adapting measures from other scholars, we avoided complex items. We collected data from the same source, but at different times. Additionally, Herman's single-factor analysis revealed that one factor accounted for 24.3% of the variance below the recommended 50% (Podsakoff *et al.*, 2003). To eliminate any doubt in regards to CMB, which Herman's single-factor analysis was unable to detect. Latent common method factor was calculated by adding latent constructs with no uniquely observed indicators (Kock *et al.*, 2021). Results of the study indicate there is no common method variance between models with and without common factors (Chin *et al.*, 2013).

3.6 Data analysis

Using covariance-based structural equation modeling and Analysis of Moments of Structures helped to understand the relationship between latent variables. It creates more realistic models than if you used standard multivariate statistics or multiple regression models. The direct and indirect hypotheses were tested. In order to test the significance of multiple hypotheses, 5,000 sub-samples were bootstrapped using a 95% biased confidence interval (Sahoo, 2019; Zhao *et al.*, 2010). Based on the Chi-square/df < 5, Goodness of Fit Index, Comparative Fit Index, Tucker-Lewis Index > 0.95 and the Root Mean Square Error Approximation of 0.08 (Sahoo, 2019).

4. Results

4.1 Unit of analysis characteristics

Table 2 shows that the majority of manufacturing companies have been in business for 2–10 years, followed by 11–20 and 21–50 years. Because of their long history of operation, Ugandan manufacturing companies can build SCRE capabilities. Manufacturing cement, clay, ceramics, chemicals, paint and soap was the most common occupation, while publishing and printing were the least common. Most companies employ between five and 100 people, followed by 501–1,000, 1,000–2000 and more than 2000. In businesses with a turnover above 10 million and 5–10 million, disruptions were significant.

4.2 Unit of inquiry characteristics

Table 3 reveal that production was the department with the most respondents, followed by sales/marketing, procurement, logistics and finance. Thus, most respondents were familiar with their companies' supply chains. More than half of manufacturing firm employees have worked for the company for more than five years. Meaning they have more knowledge and can answer more informedly. Masters and PhDs had the lowest education levels, demonstrating their ability to interpret questions. Moreover, most respondents were between 31 and 40 years old, followed by 21–30 years, 41–50 years and above 50 years old. Males are more likely to manage manufacturing firms because of their flexibility.

4.3 Hypothesis results

As presented in Table 4 and Figure 5, SCII is positively and significantly related to SCRE ($\beta = 0.15, p = 0.02$), while SCII and SCI have a significant and positive relationship ($\beta = 0.51, p = 0.036$) that supports H₁, H₂ and H₃. Companies that collaborate and share information can easily innovate and become more resilient to disruptions. SCI partially mediates SCII and SCRE ($\beta = 0.074, p = 0.019$). Similarly, SCRE is influenced by firm size and age but not by industry. Size and industry also have a significant impact on supply chain innovation. SCII and SCI influence SCRE by 41% when considering firm size, age and industry.

<i>Org.Age</i>	<i>F</i>	<i>%</i>	<i>Manufacturing sector</i>	<i>F</i>	<i>%</i>
2–5 years	94	23.3	Food processing, beverage and tobacco	90	22.3
6–10 years	111	27.5	Textile clothing and footwear	49	12.2
11–20 years	80	19.9	Paper, publishing and printing	19	4.7
21–50 years	97	24.1	Chemical, paint and soap	84	20.8
Above 50 years	21	5.2	Cement, clay and ceramic products	86	21.3
<i>Total</i>	<i>403</i>	<i>100</i>	Metal products	75	18.6
<i>Business ownership</i>	<i>F</i>	<i>%</i>	<i>Total</i>	<i>403</i>	<i>100</i>
Locally owned	288	71.5	<i>Number of employees</i>	<i>F</i>	<i>%</i>
Foreign	115	28.5	5–100	226	56.1
<i>Total</i>	<i>403</i>	<i>100</i>	101–500	52	12.9
<i>Annual sales turnover</i>	<i>F</i>	<i>%</i>	501–1,000	64	15.9
Less than 5,000,000	64	15.9	1,001–2000	26	6.5
5,000,000–10,000,000	119	29.5	Above 2000	35	8.7
Above 10,000,000	220	54.5	<i>Total</i>	<i>403</i>	<i>100</i>
<i>Total</i>	<i>403</i>	<i>100</i>			

Table 2.

Unit of analysis

Characteristics results

Source(s): Primary data

						Influence of SCII on SCI and SCRE	
<i>Department</i>	<i>F</i>	<i>%</i>	<i>Education level</i>	<i>F</i>	<i>%</i>		
Owner managers	89	11	Certificate	111	13.8		
Logistics/supply chain management	104	12.9	Diploma	165	20.4		
Purchasing	148	18.3	Degree	466	57.7		
Production	205	25.4	Masters	42	5.2		
Sales/marketing	186	23	PhD	2	0.2		
Finance	75	9.3	Professional	21	2.6		
<i>Total</i>	<i>807</i>	<i>100</i>	<i>Total</i>	<i>807</i>	<i>100</i>		
<i>Tenure</i>	<i>F</i>	<i>%</i>	<i>Age of respondent</i>	<i>F</i>	<i>%</i>		
Less than 2 years	130	16.1	21–30 years	333	41.3		
2–5 years	368	45.6	31–40 years	394	48.8		
6–10 years	212	26.3	41–50 years	73	9		
Above 10 years	97	11.96	50+ years	7	0.9		
<i>Total</i>	<i>807</i>	<i>100</i>	<i>Total</i>	<i>807</i>	<i>100</i>		
<i>Management level</i>	<i>F</i>	<i>%</i>	<i>Gender of respondents</i>	<i>F</i>	<i>%</i>		
Low level	143	17.7	Male	405	50.2		
Middle level	447	55.4	Female	402	49.8		
High level	217	26.9	<i>Total</i>	<i>807</i>	<i>100</i>		
<i>Total</i>	<i>807</i>	<i>100</i>					

Source(s): Primary data

Table 3.
Unit of inquiry
characteristics results

			β	SE	Critical Ratio (CR)	Confidence Interval (CI)		<i>p</i> -value
						LB	UB	
<i>Direct effects</i>								
SCRE	<—	Firm size	0.39	0.04	11.83	0.28	0.54	0.000
SCRE	<—	Firm Age	0.16	0.04	4.03	0.09	0.23	0.000
SCRE	<—	Industry	0.03	0.07	0.22	−0.06	0.09	0.517
SCI	<—	Firm size	0.14	0.05	2.8	0.04	0.24	0.009
SCI	<—	Industry	0.09	0.04	2.25	0.02	0.18	0.043
SCRE	<—	SCII	0.22	0.05	5.56	0.18	0.38	0.000
SCI	<—	SCII	0.51	0.06	8.14	0.36	0.59	0.001
SCRE	<—	SCI	0.15	0.06	2.17	0.02	0.27	0.021
<i>Indirect effects</i>								
SCRE	<—	SCI <— SCII	0.074	0.033	2.24	0.009	0.14	0.019
<i>Total effects</i>								
SCRE	<—	Firm size	0.41	0.06	6.83	0.303	0.514	0.000
SCRE	<—	Firm Age	0.16	0.04	4.00	0.091	0.235	0.000
SCRE	<—	Industry	0.04	0.04	1.00	0.039	0.117	0.313
SCI	<—	Firm size	0.14	0.05	2.80	0.038	0.239	0.009
SCI	<—	Industry	0.09	0.04	2.25	0.002	0.175	0.043
SCRE	<—	SCII	0.30	0.05	6.00	0.204	0.386	0.000
SCI	<—	SCII	0.51	0.06	8.50	0.389	0.621	0.000
SCRE	<—	SCI	0.15	0.06	2.50	0.030	0.013	0.013

Source(s): Primary data

Table 4.
Hypotheses results

5. Discussion of the findings

SCII and SCRE are significantly correlated. This allows companies to detect disruptions early, respond to them appropriately and mitigate their effects. Additionally, sharing information internally and externally can improve security. By doing so, it will detect early

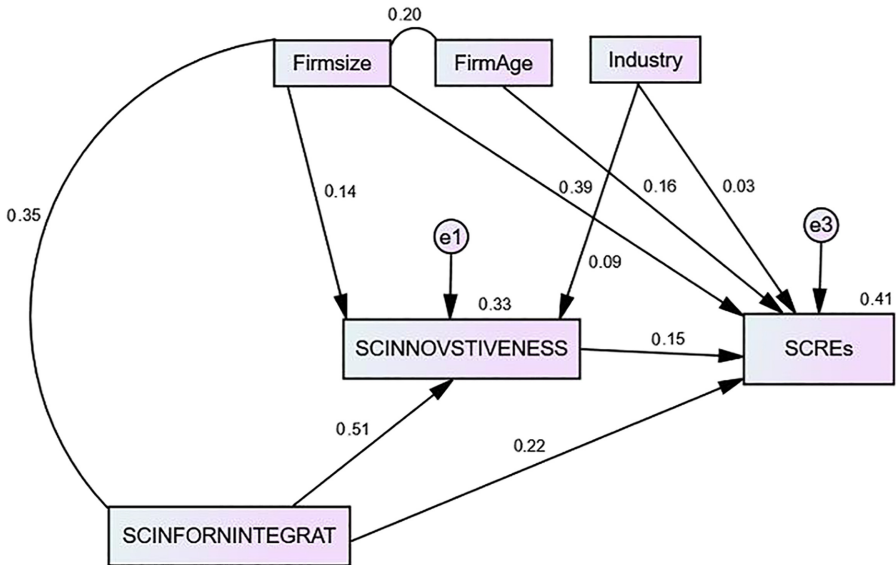


Figure 5.
Structural equation
model for supply chain
resilience

Note(s): CMIN (X^2) = 8.332, DF = 5, $p = 0.139$, CMIN/DF = 1.666, GFI = 0.993, AGFI = 0.971, NFI = 0.982, RFI = 0.946, CFI = 0.993, IFI = 0.993, TLI = 0.978, RMSEA = 0.041; PCLOSE = 0.561

warnings and provide resources to handle supply chain crises. [Siagian et al. \(2021\)](#) believe firms can collaborate with customers to meet demand disruptions. [Siagian et al.](#) argue that information buffers firms from customers. Customers are included in long-range planning to minimize disruptions caused by complexity. Additionally, manufacturing companies collaborate with suppliers from different regions during product development. Consequently, they develop alternative parts and components to avoid risks specific to certain regions. Through integration of the business processes of each tier of the supply chain, SCRE can be enhanced by [Zavala-Alcivar et al. \(2020a\)](#) and [Carissimi et al. \(2023\)](#). Compared to this, [Piprani et al. \(2020\)](#) report that supply chains with multiple stakeholders (internal, external and vendors) are more resilient.

Similarly, SCII and SCI are significantly correlated. This indicates that firms can harness the innovative ideas of internal and external stakeholders by exchanging information and collaborating on planning. Employees who share proprietary information with other supply chain partners are more likely to think outside the box in this study. They are more likely to share, exchange, and experiment with them. Similarly, [Medase and Abdul-Basit \(2020\)](#) note that SCII influences innovation. Through SCII, companies can access external knowledge to complement their internal capabilities. Equally, companies that seek long-term market research and involve their customers and suppliers will succeed. This can be achieved by removing barriers and redirecting resources to innovation pathways. In [Pihlajamaa et al. \(2019\)](#) study, companies with more suppliers create more innovative products. This finding contributes to dynamic capability theory ([Teece et al., 1997](#); [Teece, 2020](#)), which posits that human and systems capacity are important during times of uncertainty.

SCI and SCRE have a positive relationship. This shows that companies with cutting-edge solutions are more likely to rebound from supply chain disruptions. Manufacturers that encourage employees to think outside the box, provide them with the opportunity to share

innovative ideas, integrate different departments internally and share information with external suppliers are likely to succeed. During times of disruption, manufacturers that create marketable products are more adaptable. Establishing novel products, adjusting production schedules, increasing volume, varieties and distribution, as well as securing flexible contracts. Removing barriers to innovation and redirecting existing resources can support flexible ventures. Earlier studies by [Akm Ateş et al. \(2022\)](#) and [Al-Hakimi et al. \(2021\)](#) showed that firms' ability to innovate positively makes them more proactive and reactive during supply chain disruptions.

Further, SCII and SCRE are partially mediated by SCI. SCII is directly related to SCRE and indirectly to SCI. Indirect paths influence SCRE by 33.36%. According to [Negri et al. \(2021\)](#), firms can become more resilient over time by sharing information and collaborating with other supply chain partners. Information is shared and collaboration is efficient when manufacturers collaborate with external stakeholders. Long-range planning and testing can turn ideas into marketable products/services. It is possible to achieve flexibility by removing barriers. In addition, manufacturers with diversified product portfolios can collaborate with technology centers. Furthermore, we confirm those of [Kochan and Nowicki \(2018\)](#) and [Spieske and Birkel \(2021\)](#). According to dynamic capability theory, firms achieve new resource configurations by evolving organizational procedures ([Medeiros et al., 2020](#)).

5.1 Conclusion

Among manufacturing firms, SCI plays a partial mediating role between SCII and SCRE. Among SCII and SCRE, SCI contributes 33.34%. Based on the dynamic capabilities theory ([Medeiros et al., 2020](#)), we argue that innovation and information are strategies and routines firms use to achieve new resource configurations as markets develop, collide, split, evolve and die.

5.2 Theoretical implication

As per dynamic capability theory, SCII and SCI cause SCRE. Understanding SCRE trajectory involves the ability to integrate information and innovation. In this study, findings show that SCIs mediate the relationship between SCII and SCRE. Innovation tools like information integration facilitate firm resilience. Additionally, SCRE has been studied primarily in industrialized countries. This article acknowledges that developing countries need to strengthen their manufacturing sectors by addressing supply chain disruptions in times of uncertainty.

5.3 Practical implication

For SCRE to increase, manufacturing executives must embrace SCII. By sharing information and collaborating with suppliers and customers, we can avoid disruptions in ongoing product development. It is also critical for management to share proprietary information with internal and external stakeholders. This will enable them to identify early warning signs of change and mitigate them as quickly as possible. SCIs and SCRE complement each other. A prompt response is necessary to manage disruptions. It is, therefore, imperative to provide employees with the resources and time they need in order to experiment. Furthermore, they should collaborate with external partners in the supply chain and integrate their internal processes more effectively. SCII and SCRE are partially mediated by SCI in this study. Business-to-business platforms should be mandated for manufacturers during supply chain disruptions. Exhibitions, trade shows and foundations are among these platforms. In order to reach the market, managers need to remove barriers and invest in new resources.

5.4 Limitations and areas of other study

There is limited generalizability and transferability due to the cross-sectional design. In addition, samples were collected from manufacturers in the Central, Kampala and Jinja districts. The only predictors of SCRE were SCII and SCI. Further studies may identify additional variables. Integration of supply chain information will boost innovation to become resilient, thus establishing SCII as a moderator between SCI and SCRE is vital.

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