

# The role of agility in responding to uncertainty: A cognitive perspective

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## ABSTRACT

This research investigates the impact of external environment, cognitive factors, and behavioral dimensions in the context of implementing supply chain agility. It applies social cognitive theory to establish a link between various environments including business uncertainty and supply chain disruption risk, cognitive factors such as supply chain agility self-efficacy, trust, and supply chain cooperation, coordination, and communication attitude, and actions such as implementing supply chain agility as well as behavior to explain the decision-making process in implementation. Based on the survey data collected from 254 supply and purchasing managers in the Korean manufacturing industry, AMOS software with structural equation method was used for data analysis. Our results support the concept that business uncertainty reduces self-efficacy in supply chain agility although both business uncertainty and supply chain disruption risk boosted trust in the supply chain as well as buyers' positive attitude toward supply chain cooperation, coordination, and communication. The concept of supply chain agility, self-efficacy, trust, and supply chain cooperation, coordination, and communication attitude have a positive impact on firm performance. Supply chain agility, self-efficacy, and trust in suppliers positively affects implementation of supply chain agility as well as firms' financial, operational, and supply chain performance. This research provides meaningful insights for considering external environments and cognitive factors while making decisions in implementing supply chain agility.

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## 1. Introduction

Competition has intensified in the market and business environments have become dynamic. As customer requirements for organizations have increased, the ability to adjust to shorter product lifecycles, longer lead times, higher supply volatility, and unpredictable demand has become essential [1]. Organizations must have agility to respond quickly to changes in the industry as well as markets. In managing a supply chain, agility has emerged as a solution for improving flexibility in the market. Organizations with supply chain agility provide higher service levels although their inventories are lower [2]. More importantly, due to increased complexity, business uncertainty has been considered as one of the most important factors for managers to deal with and generate solutions. With increased levels of turbulence as well as unpredictability, organizations emphasize on the need to develop agility to offer superior value to customers in

managing flow of materials and services without any disruptions [3]. Therefore, supply chain agility has emerged as an important issue in the management and operation of supply chains in both academia and industry.

The concept of supply chain agility has recently been discussed in supply chain and operations management from a different perspective. The concept of supply chain agility is considered as the capability of firms to respond to market changes [4]. Supply chain agility is defined as firms' ability to determine and quickly respond to market changes in their supply chain from an internal supply chain perspective [3]. Gligor and Holcomb [1] provide a similar definition of supply chain agility recognizing it as the ability of the supply chain network to align its operations with the market quickly and proactively. Based on this definition, the research efforts of Gligor *et al.* [5] culminated in establishing five dimensions of supply chain agility: alertness, accessibility, decisiveness, swiftness, and flexibility. This research applies the definition of supply chain agility, namely firms' ability to adjust supply chain operations quickly, based on the study of Gligor and Holcomb [1], Gligor *et al.* [5] Gligor *et al.* [6] and the approach that supply chain agility is closely tied to effectiveness in managing supply chains [6].

Social cognitive theory (SCT) has been applied to various fields, but mainly to explain individual and group behavior by interacting with cognitive factors as well as external environments. The theory attempts to identify people's behavior based on a framework of interactions between cognitive factors, environmental factors, and human behavior [7]. Thus, based on the interplay between these factors, this theory predicts that human behavior is influenced by cognitive, affective, personal factors, and external environments [7]. By applying SCT, this research investigates the relationship between a firm's cognitive decisions in implementing supply chain agility by reacting to external environments. As this study considers cognitive factors as the focal point of these relationships, it examines the role of supply chain agility, self-efficacy, trust, supply chain cooperation, coordination, and communication attitude in the implementation of supply chain agility as well as firm performance in response to business uncertainties and supply chain disruption risk.

Applying social cognitive theory and definition of supply chain agility, firms' ability to adjust supply chain operations quickly, this research established self-efficacy in the context of supply chain agility. Thus, supply chain agility self-efficacy is defined as a confidence on managing supply chain with agility. When supply chain managers deal with business uncertainty and risk, their confidence make a critical impact on their decision makings. Therefore, supply chain agility self-efficacy is considered as one of the most important cognitive factors in explain managerial behaviors.

Based on SCT, this study identifies the antecedents of supply chain agility and explains how managers' cognitive, affective, personal factors in events such as self-efficacy in supply chain agility, achieving trust in supply chain relationships, supply chain cooperation, coordination, and communication affect actual implementation of supply chain agility as well as firm performance. Although prior studies investigate the antecedents of supply chain agility as well as performance, this research attempts to identify the cognitive aspects of the antecedents in the implementation of supply chain agility and investigates the relationships between cognitive factors and supply chain agility including the relationship between implementation of supply chain agility and firm performance.

## 2. Theoretical background and literature review

### 2.1 Theoretical background

Social cognitive theory establishes a theoretical framework to understand the interactions between human behavior and personal and environmental factors [7, 8]. According to SCT, personal and environmental factors closely interact with each other and influence human behavior. Environmental factors modify and involve human beliefs, while cognitive and personal factors affect individual actions. Therefore, SCT can be used to explain human behavior depending on personal and environmental factors [7, 8]. This research applies SCT to explain the behavioral

intention of supply managers and executives in implementing supply chain agility and improving firm performance. Thus, our study investigates how environmental and cognitive factors impact managerial decision making for supply chain agility.

This research considered business uncertainty and supply chain disruption risk as the business environmental factors affecting managers' cognitive and personal factors [9, 10]. Supply chain self-efficacy, trust, and supply chain cooperation, coordination, and communication attitude as cognitive and personal factors influencing managerial behavior. This study selected implementation of supply chain agility as well as firm performance as actual behavior and outcomes relating to personal factors.

## 2.2 Literature review

In a supply chain, firms need to establish a strategy to deal with unexpected disruptions as well as uncertainties. Supply chain disruption is defined as an event that disrupts flows of goods and services, information, and money in a supply chain [11]. Supply chain disruptions generate financial difficulties for suppliers as well as downstream members of the supply chains [12]. Those disruptions are caused by various disturbances such as disease like COVID-19, environmental disasters like tsunami, hurricane and earthquake, and international conflicts like the local wars. These disturbances contain the expectancy and lead to potential risk of disruptions in the supply chain. Since they are coming from outside of the supply chain, the risk of supply chain disruptions interacting with market and technology turbulence and unexpected events such as natural disasters inclines supply chain disruption risk to external environmental factors [13].

Business uncertainty refers to environmental factors and may be interpreted as uncertainties of effect, condition, name, and response and generated by various sources [14]. Business uncertainty is considered a critical factor because it forms the basis for making a cognitive decision [15]. Since this study considers business uncertainty as an environmental factor, it applies the measurement of level of unpredictability in business environments following the research of Kocabasoglu *et al.* [16]. Further, their research established four dimensions of business uncertainty: munificence, dynamism, hostility, and heterogeneity [17]. This research adopts business uncertainty and supply chain disruption risk as external environmental factors because managers need to consider and deal with those two factors when making cognitive decisions based on SCT.

Trust has been widely discussed in supply chain management literature and has been defined as willingness to rely on supply chain partners the organization is confident about [18]. In inter-firm settings of the supply chain, trust is considered as an expected action that is desired by supply chain partners; therefore, trust plays a key role in firm behavior when there is uncertainty in the supply chain [19]. Trust must be necessary for supply chain members to increase asset-specific investments [20]. It also reduces minimal requirement and monitors and controls partners' actions, reduces conflict in supply chain relationships leading to successful supply chain management [18]. Thus, trust is considered an important antecedent for establishing good supply chain relationships as well as boosting collaboration in the supply chain [21].

Supply chain cooperation generates various benefits in the supply chain, especially reducing stock holdings for retailers, manufacturers, and distributors [22]. Supply chain coordination has a positive impact on supply chain performance [23]. Communication within a supply chain boosts integration, thereby increasing collaboration in the supply chain [24]. These mechanisms (cooperation, coordination, and communication) are empirically validated to show that they have a positive impact on supply chain agility [1]. Although actual implementation of supply chain cooperation, coordination, and communication are examined in the context of supply chain agility, this research investigates the role of trust and attitude toward supply chain cooperation, coordination, and communication as cognitive, affective, and personal factors in the context of SCT affecting actual implementation of supply chain agility as well as performance.

Supply chain agility (SCA) is defined as a supply chain's ability to respond quickly to changes in business environments [4]. However, since supply chain agility focuses on outcome measures, it applies to the focal firm's capability. Therefore, a firm's supply chain agility is its ability to work with suppliers and customers and adjust to and respond quickly to changing market dynamics by improving its supply chain capabilities [3]. Gligor and Holicomb [1] also emphasized

the importance of supply chain agility in the context of a firm's ability to adjust its operations proactively. The research of Gligor *et al.* [25] summarized supply chain agility into six themes: ability to quickly change directions, ability to speed/accelerate operations, ability to scan the environment/anticipate, ability to empower the customer/customize, ability to adjust tactics and operations, and ability to integrate process and within across firms. More importantly, environmental uncertainty also is closely linked to the concept of supply chain agility [25].

While the definition of supply chain agility has been discussed from the perspective of quick response, the research of Gligor *et al.* [5] classified firms' supply chain agility into two distinct dimensions: cognitive and physical. Notably, the concept of supply chain agility includes the cognitive ability to respond swiftly to changes as well as actions [6, 26]. Thus, this research investigates the impact of supply chain agility from the cognitive perspective as self-efficacy in supply chain agility, and the physical dimension as implementation of supply chain agility.

Based on the definition of supply chain agility, cognitive ability to make a quick respond quickly to market dynamics [3, 5], this research developed the concept of supply chain agility self-efficacy by reflecting Bandura's social cognitive theory. Self-efficacy represents that it promotes positive outcome due to more confidence in their skills [27]. Self-efficacy has been applied in various decision making contexts. Career decision-making self-efficacy means the level of individuals' confidence of their ability to perform the tasks [28]. Computer self-efficacy indicates individuals' beliefs regarding using computers to solve problems [29]. By applying self-efficacy in supply chain agility, this research applied self-efficacy in supply chain agility to supply chain managers' cognitive perspective. Therefore, our study defined supply chain agility self-efficacy as managers' confidence level on managing supply chain with agility in a cognitive perspective. This research investigates the managers' confidence level in supply chain agility in order to deal with supply disruption risk as well as business uncertainty.

### 3. Research model and hypotheses

Business uncertainty leads to the establishment of multiple communication channels among firms for the smooth flow of goods and information, resulting in more frequent interactions in the supply chain [30]. Additionally, supply chain managers quickly establish and implement supply chain strategies in response to environmental changes and to survive in highly competitive markets [9]. Further, managers' cognitive, affective, and personal factors in decision making are critical to business uncertainty.

A significant impact of business uncertainty is that it prevents managers from making risky investment decisions from the cognitive, affective, and personal perspectives [31]. Although previous research posits that business uncertainty encourages supply chain managers to implement supply chain practices such as integration [9], business uncertainty increases the risk propensity inherent in a supply chain [16]. This cognitive process has helped managers to avoid risks in their decisions and adopt new practices such as implementation of supply chain agility.

In SCT, external environmental factors such as business uncertainty influence managers' beliefs or self-efficacy as well as cognitive competencies that require quick response in decision making like self-efficacy in supply chain agility [7]. Cognitive hesitation caused by business uncertainty as well as lack of control reduces confidence in decision making. Thus, lack of control on the external environment is negatively related to self-efficacy in a start-up business [32]. Business uncertainty is negatively associated with changes in managers' perceived self-efficacy [33]. Thus, this research proposes hypothesis 1 as negative association between business uncertainty and managers' supply chain agility self-efficacy as follows:

*H1. Business uncertainty is negatively associated with buyers' supply chain agility self-efficacy.*

Firms encounter business uncertainty from demand variations and technology development. To ease business uncertainty, firms in a supply chain seek stable relationships with their partners [34]. Business uncertainty is considered an unpredictable factor in supply chain relationships. In a volatile business environment, buyers find it difficult to estimate the outcome of purchasing decisions and from maintaining healthy relationships so that good business exchanges generate

positive results with trust [35]. By fostering trust, supply chain relationships can build mutual commitment and shared values [36]. Increased business uncertainty strengthens trust between organizations [34]. When business uncertainty escalates in a supply chain, buyers strengthen trust with suppliers to maintain a close relationship in the supply chain. Therefore, this study posits the positive relationships between businesses uncertainty and buyers, and perceived trust in suppliers in hypothesis 2:

*H2. Business uncertainty positively affects buyers' trust in suppliers.*

Business uncertainty generates an inherent situation where interactions among firms are caused due to the involvement of multi-channel communications. Further, higher business uncertainty forces supply chain members to increase collaboration and coordination with more information [30]. In the context of uncertainty in demand, supply, and technology, increasing business uncertainty reinforces supply chain relationships, including cooperation and communications [37]. In supply chain environmental management, cooperation strengthens if business uncertainty increases [38]. As business uncertainty emerges in supply chains, buyers' efforts to improve supplier involvement to increase supply chain cooperation, coordination, and communication, results in motivating a positive mindset and attitude for working with suppliers. Thus, to overcome business uncertainty, this research proposes positive association between business uncertainty and buyers' attitude toward supply chain cooperation, coordination, and communication in hypothesis 3:

*H3. Business uncertainty has a positive impact on buyers' attitude toward supply chain cooperation, coordination, and communication.*

Firms use two dimensions to evaluate and measure supply chain disruption risk: probability and magnitude of risk, as perceived and judged by buyers [39]. To manage supply chain disruption risk, firms develop infrastructure and strategies for risk management and quick response [11]. However, perceived supply chain disruption risk interacts with supply and purchasing managers' confidence for making quick decisions. Managers with high self-efficacy tend to take higher risks [33]. On the opposite direction between risk and confidence, managers with high risk-tolerance levels tend to show greater confidence in their decision making, indicating that higher risk reduces confidence in decision making [40]. Meanwhile, Christopher and Lee [41] show that supply chain disruption risk reduces confidence in the supply chain, requiring responsive action. High supply chain disruption risk reduces the confidence in making a quick response action for supply chain agility. Thus, our study posits a negative relationship between supply chain disruption risk and buyers' supply chain agility self-efficacy in hypothesis 4:

*H4. Supply chain disruption risk is negatively associated with buyers' supply chain agility self-efficacy.*

Adding to the negative impact on confidence in supply chain agility, perceived supply chain disruption risk affects the entire supply chain network. Supply chain disruption risk demonstrates that exposure to disruption affects the relationship between members of the supply chain [42]. However, in high-risk environments, firms attempt to use integration with suppliers to mitigate supply chain disruption risk and improve cost and innovation performance [43]. The foundation of this relationship is trust. If trust increases in supplier relationships, the effect of sharing risk information with suppliers will help in improving firms' financial performance [44]. Perceived supply chain disruption risk leads to increased trust by generating many opportunities for strengthening relationships with supply chain members, as proposed in hypothesis 5

*H5. Supply chain disruption risk positively affects buyers' trust in suppliers.*

In dealing with supply chain disruption risk, firms use risk management strategies and practices for mitigation. Juttner [42] pointed out that firms tend to increase open discussion, communication, as well as cooperation with supply chain members. Riche and Bradely [45] also emphasized close collaboration, effective communication, and strong relationships in mitigating supply chain disruption risk. The study of Blos *et al.* [46] mentioned the importance of better communications

as well as coordination of business processes in a supply chain. As a risk management solution, firms attempt to increase supply chain cooperation, coordination, and communication to deal with perceived supply chain disruption risk. Such trials help to generate positive attitude toward supply chain cooperation, coordination, and communication. Thus, this research proposes hypothesis 6:

*H6.* Supply chain disruption risk has a positive impact on buyers' attitude toward supply chain cooperation, coordination, and communication.

In management studies, many researchers investigate the relationship between self-efficacy and actions. Entrepreneurial self-efficacy is considered to be one of the most important antecedents in establishing the entrepreneurship process [47]. To facilitate entrepreneurship, developing entrepreneurial capabilities helps to improve self-efficacy and pursue it as a career choice [48]. In computer usage, self-efficacy plays a significant role as it leads to easy use of computers from a user perspective [49]. If managers have high confidence in supply chain agility, it leads to action on implementing supply chain agility. Thus, firms with self-efficacy in supply chain agility tend to implement supply chain agility for better results, as proposed in hypothesis 7:

*H7.* Self-efficacy in supply chain agility is positively associated with buyers' implementation of supply chain agility.

Self-efficacy is considered a predictor of future performance, especially in the context of task [50], and is applied to improve employees' job performance. Job self-efficacy and creative self-efficacy are key attributes associated with workplace performance [51]. In using computers, self-efficacy has a direct impact on both intentional behavior of computer usage and ease of use, thereby helping to use computers [52]. Self-efficacy in computers improves performance in learning and using computers and is positively associated with learning engagement [29]. Self-efficacy in supply chain agility as managers' cognitive factor positively affect firms' comprehensive performance like implementation of supply chain agility self-efficacy as an action. Thus, this research proposes hypothesis 8 to show that self-efficacy in supply chain agility improves firms' performance including financial, operational, and supply chain:

*H8.* Self-efficacy in supply chain agility positively affects buyers' financial, operational, and supply chain performance.

Trust plays a positive role in supply chain management. Although trust has a cognitive form, it is expressed as a behavioral dimension. Notably, in supply chain relationships, trust creates more frequent exchange of communication and motivates suppliers to receive royalty from buyers so that buyers' trust in suppliers improves the responsiveness in a supply chain [53]. In the context of strategic sourcing, trust is considered a critical factor in improving supply chain agility [54]. Prior studies emphasized that trust is a strong driver in improving supply chain agility [55]. Thus, in hypothesis 9, our study proposes that buyers' trust in suppliers leads to buyers' decision in implementing supply chain agility:

*H9.* Buyers' trust in suppliers is positively associated with buyers' implementation of supply chain agility.

Trust has a positive impact on firms conducting various supply chain practices. Trust is positively associated with alliance performance due to the fact that it strengthens the relationship between allied companies [56]. Trust is also a very important mechanism in improving the performance of joint research and development projects [57]. However, a few studies have attempted to investigate the direct association between trust and firms' performance including financial, operational, and supply chain aspects. Capaldo and Giaannoccaro [58] used a simulation model to show that trust has a positive impact on supply chain performance and a moderating effect on the relationship between supply chain interdependence and supply chain performance. Thus, buyers' trust is positively associated with the total aspects of performance, as proposed in hypothesis 10:

*H10.* Buyers’ trust in suppliers positively affects buyers’ financial, operational, and supply chain performance.

Broadly, supply chain agility is positively affected by internal integration, and integration among suppliers including cooperation, coordination, and communication, and integration with suppliers [3]. While cooperation in a supply chain is considered one of the most important antecedents for improving supply chain agility [59], communication and cooperation also improve agility in a supply chain [60]. Supply chain cooperation, coordination, and communication are positively associated with supply chain agility [1]. Thus, this study proposes in hypothesis 11 that buyers’ positive attitude toward supply chain cooperation, coordination, and communication leads to actual implementation of supply chain agility:

*H11.* Buyers’ positive attitude toward supply chain cooperation, coordination, and communication are positively associated with implementation of supply chain agility.

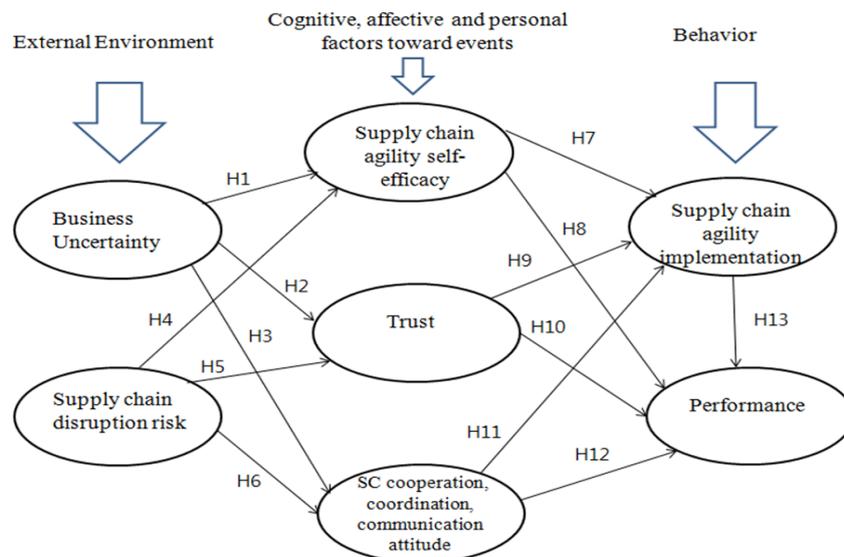
Prior studies mentioned the positive impact of supply chain cooperation, coordination, and communication on firm performance. In green supply chain management, supplier partnerships have a positive impact on the firm’s environmental and organizational performance [61]. Investments in supply chain coordination improve a firm’s delivery performance [62]. Supply chain information exchange, coordination, and integration improve a firm’s financial and market performance [63]. Based on these discussions, this research attempts to establish a positive association between buyers’ positive attitude toward supply chain cooperation, coordination, and communication and the various aspects of firm performance, as in hypothesis 12:

*H12.* Buyers’ positive attitude toward supply chain cooperation, coordination, and communication positively affects buyers’ financial, operational, and supply chain performance.

In the context of supply chain management, supply chain agility positively affects both operational and relational performance [1]. Besides, supply chain agility is positively associated with a firm’s financial performance and return on assets through cost efficiency and effective customer response, given the advantage of responding quickly to customers [6]. More importantly, supply chain agility generates positive outcomes in supply chain relationship as well as firms’ performance. Our study proposes in hypothesis 13 that buyers’ implementation of supply chain agility improves firms’ financial, operational, and supply chain performance:

*H13.* Buyers’ implementation of supply chain agility has a positive impact on their financial, operational, and supply chain performance.

Figure 1 describes our research model.



**Fig. 1** A research model

## 4. Methodology

### 4.1 Instrument development

For validating our research hypotheses with industry data, survey questionnaires were developed by reviewing prior literature. All questionnaires in the measurements were revised to reflect the context of supply chain management. Business uncertainty, representing the dynamics of business environments, is measured with 6 items [16, 30]. Supply chain disruption risk indicating perceived risk of disruption in the supply chain is measured using 7 items [11, 39]. Supply chain agility self-efficacy, representing confidence levels regarding supply chain agility, is measured with 11 items [3, 4, 6]. This construct is based on supply chain agility combining self-efficacy concept that measured degree of managers' confidence toward supply chain agility in their cognitive perspective. In other words, all 11 items captured managers' confidence level on 11 items of definition of supply chain agility which are used in measuring implementation of supply chain agility in this survey questionnaires at the same time. Trust in suppliers, representing buyers' trust in suppliers in a supply chain relationship, is measured with 6 items [19, 20]. Supply chain cooperation, coordination, and attitude to communication are measured by 6 items indicating buyers' attitude and willingness to cooperate, coordinate, and communicate with suppliers [1, 64]. Implementation of supply chain agility as the actual behavioral dimension of implementing supply chain agility is measured using 11 items and these are consistent with supply chain agility self-efficacy items [3, 4, 6]. Finally, performance of three dimensions: financial, operational, and supply chain is measured in 12 items and compared with industry averages [65, 66].

After completing the first version of the survey, based on the literature review of previous studies, this research conducted intensive interviews with five supply, purchasing, and supply chain managers, including supply and purchasing executives from manufacturing industries. During the interviews, we received feedbacks on the measurement items as well as the survey for content validation, helping the survey to use proper terms in the industry. Using the modified survey, we executed a pilot study with a group of 31 experts (supply, purchasing, supply chain managers, and supply and purchasing executives) to improve a level of reliability and validity in the contents of the survey. All the statistical results, Cronbach's alpha, of the pilot study on measurement reliability were greater than 0.7, which was high enough to ensure that no measurement items were necessary to be eliminated.

After the pilot study, we finalized the survey such as scale, content, wording, and length. Our research utilized a 7-point Likert scale with response categories from 1 (strongly agree) to 7 (strongly disagree). For measurement purification, confirmatory factor analysis (CFA) with the maximum likelihood estimation (MLE) method was conducted with AMOS 20. This research also evaluated unidimensionality, reliability, convergent validity, and discriminant validity. They are presented in Tables 1 and 2.

### 4.2 Study sample

The target subjects of this research were supply, purchasing, and supply chain managers, including supply and purchasing executives who were capable of answering all questions properly in the survey designed for manufacturing firms in Korea. Firm level was the unit of analysis. We collected the surveys from various firms that manufactured automobiles, automobile components, various electronic products, various electronic product components textiles, clothing and related products, heavy equipment as well as its components, chemicals, healthcare products and equipment, furniture, metal products, and numerous consumable goods.

This research used firm size as a control variable since smaller firms need to deal with fewer resources for implementing supply chain management practices. A company's annual sales were used to measure firm size [6]. 50 firms with annual sales of firms less than \$500 million, 39 firms from \$500 million to \$1 billion, 41 firms with \$1 billion to \$2 billion, 39 firms from \$2 billion to \$3 billion, 43 firms with \$3 billion to \$4 billion and finally, 40 firms with more than \$ 4 billion among 252 firms.

Further, 900 paper-based survey questionnaires were randomly distributed to supply, purchasing, and supply chain managers, including supply and purchasing executives in Korean manufacturing firms on April, 2017. Nearly 260 responses were returned with a response rate of 28.88 % on May, 2017. However, 8 surveys were incomplete as they were marked with a single answer, resulting in 252 completed responses, which were used for data analysis. One respondent from each manufacturing company, a buyer in a supply chain as a focal firm did not complete one survey.

This research assessed the non-response bias following the approach outlined in the study of Mentzer and Flint [67]. About 111 non-respondents were randomly contacted by email and statistically no significant differences were found between the answers given by respondents and non-respondents. Although we received responses for only two weeks, our study compared the answers of early and late respondents and found no statistical differences. We conducted the Harman's single factor test to identify if the common method bias exists. By conducting an unrotated factor analysis, this research checked all the eigenvalues according to the research of Doty and Glick [68] and Podsakoff and Organ [69]. This result ensures that no single factor, including no first factor, has a value greater than 20 % of the variances in our research data, which confirms the no common method bias.

## 5. Results

### 5.1 Measurement model

Using AMOS, this research examined various aspects of unidimensionality, reliability, convergent validity, and discriminant validity reliability in the measurement items. Cronbach's alpha and composite reliability for our measurement items are greater than 0.7, which presents satisfactory reliability in Table 1. For assessing both convergent validity and discriminant validity, we conducted confirmatory factor analysis with AMOS and checked the comparative fit index (CFI). Our research represents a goodness of fit model with a Chi-square of 411.66 and 194 degrees of freedom, CFI = 0.920, RMSEA = 0.052, and NFI = 0.936. If CFI is greater than 0.80 and the root mean square error of approximation (RMSEA) is less than 0.08, we can conclude that the model is satisfactory [70].

For examining convergent validity, our study checked the estimated parameters between the latent variables and their indicators and the values were above 0.50 in Table 1, indicating acceptable convergent validity [71]. For assessing discriminant validity, this research compared the square root values of the average variance extracted (AVE) with correlations of constructs and observed that the square root of AVEs were greater than the correlation values suggesting adequate discriminant validity in Table 2 [72].

**Table 1** Reliability results

	Item loadings	Cronbach Alpha	Composite reliability	Item to total correlation	Average variance extracted
BU1	0.808	0.845	0.852	0.785	0.739
BU2	0.789			0.766	
BU3	0.816			0.795	
BU4	0.863			0.843	
BU5	0.794			0.771	
BU6	0.799			0.759	
SCR1	0.798	0.823	0.861	0.769	0.675
SCR2	0.863			0.844	
SCR3	0.883			0.862	
SCR4	0.818			0.800	
SCR5	0.805			0.784	
SCR6	0.817			0.792	
SCR7	0.748			0.722	
ASE1	0.848	0.851	0.880	0.801	0.702
ASE2	0.879			0.855	
ASE3	0.813			0.802	

**Table 1** (Continuation)

ASE4	0.881			0.861	
ASE5	0.739			0.715	
ASE6	0.794			0.773	
ASE7	0.877			0.856	
ASE8	0.859			0.836	
ASE9	0.772			0.758	
ASE10	0.797			0.756	
ASE11	0.890			0.881	
TRU1	0.913	0.820	0.869	0.900	0.729
TRU2	0.894			0.880	
TRU3	0.743			0.722	
TRU4	0.888			0.889	
TRU5	0.897			0.845	
TRU6	0.826			0.811	
SCA1	0.890	0.880	0.910	0.877	0.830
SCA2	0.861			0.856	
SCA3	0.821			0.809	
SCA4	0.782			0.777	
SCA5	0.735			0.736	
SCA6	0.747			0.750	
SCAI1	0.800	0.847	0.879	0.788	0.801
SCAI2	0.821			0.807	
SCAI3	0.921			0.911	
SCAI4	0.837			0.824	
SCAI5	0.802			0.800	
SCAI6	0.778			0.764	
SCAI7	0.814			0.809	
SCAI8	0.816			0.811	
SCAI9	0.886			0.874	
SCAI10	0.882			0.852	
SCAI11	0.850			0.833	
FP1	0.779	0.828	0.860	0.766	0.852
FP2	0.807			0.799	
FP3	0.818			0.805	
FP4	0.824			0.815	
OP1	0.918			0.910	
OP2	0.876			0.845	
OP3	0.881			0.877	
OP4	0.852			0.826	
SCP1	0.896			0.881	
SCP2	0.833			0.822	
SCP3	0.839			0.817	
SCP4	0.883			0.867	

Performance includes financial (FP), operational (OP) and supply chain (SCP) performance.

**Table 2** Correlation Matrix for constructs: Discriminant Validity

Variables	BU	SCR	ASE	TRU	SCA	SCAI	PERF
BU	<b>0.86</b>						
SCR	0.06	<b>0.82</b>					
ASE	0.51	0.23	<b>0.84</b>				
TRU	0.45	0.32	0.55	<b>0.85</b>			
SCA	0.46	0.52	0.58	0.55	<b>0.91</b>		
SCAI	0.51	0.24	0.48	0.48	0.48	<b>0.89</b>	
PERF	0.59	0.09	0.59	0.43	0.54	0.52	<b>0.92</b>

BU = business uncertainty; SCR = supply chain disruption risk; ASE = supply chain agility self-efficacy; TRU = trust; SCA = supply chain cooperation, coordination and communication attitude; SCAI = supply chain agility implementation; PERF = financial, operational and supply chain performance

## 5.2 Structural model

By employing structural equation modeling (SEM) to validate our research model, our results indicate a good fit for our research model with a Chi-square of 428.12 and 194 degrees of freedom, CFI of 0.927, RMSEA of 0.061, and NFI of 0.908 [73]. Hypothesis 1: Business uncertainty is

negatively associated with buyers' supply chain agility self-efficacy, was supported (CR = 5.278,  $\beta_1 = -0.496$ ,  $p < 0.001$ ). With increasing levels of business uncertainty, manufactures' confidence toward supply chain agility declines. Our research results also support hypothesis 2: Business uncertainty positively affects buyers' trust in suppliers, (CR = 5.087,  $\beta_2 = 0.431$ ,  $p < 0.001$ ). As business environments become dynamic and competitive, manufacturers' trust in suppliers would reduce. Our results provide empirical evidence for hypothesis 3: Business uncertainty makes a positive impact on buyers' attitude toward supply chain cooperation, coordination, and communication (CR = 5.019,  $\beta_3 = 0.417$ ,  $p < 0.001$ ). A high level of business uncertainty discourages a proactive approach toward cooperation, coordination, and communication with suppliers. However, hypothesis 4: Supply chain disruption risk is negatively associated with buyers' supply chain agility self-efficacy was not supported (CR = 1.165,  $\beta_4 = 0.043$ ,  $p = 0.392$ ).

Our research supports hypothesis 5: Supply chain disruption risk positively affects buyers' trust on suppliers (CR = 3.103,  $\beta_5 = 0.295$ ,  $p < 0.005$ ) and hypothesis 6: Supply chain disruption risk makes a positive impact on buyers' attitude toward supply chain cooperation, coordination, and communication (CR = 4.165,  $\beta_6 = 0.427$ ,  $p < 0.001$ ). As managers' perceived disruption risk in supply chain increases, manufacturers' trust as well as positive attitude toward cooperation, coordination, and communication with suppliers would diminish. Our research results also support Hypothesis 7: Supply chain agility self-efficacy is positively associated with buyers' implementation of supply chain agility (CR = 6.095,  $\beta_7 = 0.522$ ,  $p < 0.001$ ). Hypothesis 8: Supply chain agility self-efficacy positively affects buyers' financial, operational, and supply chain performance (CR = 4.528,  $\beta_8 = 0.316$ ,  $p < 0.001$ ) is also supported. Confidence in supply chain agility is considered as a positive antecedent for implementing supply chain agility and improving the three dimensions of firm performance. Our research results empirically confirmed hypothesis 9: Buyers' trust in suppliers is positively associated with buyers' implementation of supply chain agility (CR = 3.786,  $\beta_9 = 0.308$ ,  $p < 0.001$ ). Similarly, hypothesis 10: Buyers' trust in suppliers positively affects buyers' financial, operational, and supply chain performance (CR = 5.959,  $\beta_{10} = 0.443$ ,  $p < 0.001$ ) is confirmed. Trust in supply chain relationships also plays a positive role in implementing supply chain agility and improving firm performance.

On the other hand, hypothesis 11: Buyers' attitude toward supply chain cooperation, coordination, and communication are positively associated with buyers' implementation of supply chain agility was not supported (CR = 1.009,  $\beta_{11} = 0.0089$ ,  $p = 0.240$ ). Our research results supported hypothesis 12: Buyers' attitude toward supply chain cooperation, coordination, and communication positively affects buyers' financial, operational, and supply chain performance (CR = 4.236,  $\beta_{12} = 0.388$ ,  $p < 0.001$ ,  $p = 0.240$ ). Hypothesis 13: Buyers' implementation of supply chain agility makes a positive impact on their financial, operational, and supply chain performance (CR = 7.012,  $\beta_{13} = 0.558$ ,  $p < 0.001$ ) is also supported. Manufacturers' willingness and positive attitude toward supply chain cooperation, coordination, and communication as well as implementation of supply chain agility improves firms' performance.

Table 3 presents direct effects among factors from research results.

**Table 3** Direct effects testing results

Hypothesis No.	Path	Relationship direction	Standard weights	Critical Ratios	Supported
H1	BU→ASE	-	0.496	5.378	Yes: $p < 0.01$
H2	BU→TRU	-	0.431	5.087	Yes: $p < 0.01$
H3	BU→SCA	-	0.417	5.019	Yes: $p < 0.01$
H4	SCR→ASE	-	0.043	1.165	No: $p = 0.392$
H5	SCR→TRU	-	0.295	3.103	Yes: $p < 0.05$
H6	SCR→SCA	-	0.427	4.165	Yes: $p < 0.01$
H7	ASE→SCAI	+	0.522	6.095	Yes: $p < 0.01$
H8	ASE→PERF	+	0.316	4.528	Yes: $p < 0.01$
H9	TRU→SCAI	+	0.308	3.786	Yes: $p < 0.01$
H10	TRU→PERF	+	0.443	5.959	Yes: $p < 0.01$
H11	SCA→SCAI	+	0.089	1.009	No: $p = 0.240$
H12	SCA→PERF	+	0.388	4.236	Yes: $p < 0.01$
H13	SCAI→PERF	+	0.558	7.012	Yes: $p < 0.01$

## 6. Discussion and conclusion

This research provides meaningful implications for the academic world and the practical industry. It has filled a gap in the literature by identifying external environmental factors such as business uncertainty and supply chain risk as negative antecedents in the cognitive aspects in the context of supply chain agility. In supply chain risk management, uncertainty and risk have been discussed profoundly and prior studies provided various solutions. To mitigate business uncertainty and supply chain risk, information sharing, supply chain collaboration, and supply chain integration have been considered as appropriate solutions for supply chain management [74]. With an empirical approach, our study established an environmental-cognitive-behavioral framework for firms' decision making in implementing supply chain agility.

However, prior studies have not investigated the link between external environments that managers need to deal with such as business uncertainty and supply chain risk and cognitive factors in the context of supply chain agility. Thus, this study has addressed this gap in the literature and shows that business uncertainty reduces managers' confidence in supply chain agility while it strengthens trust and attitude for supply chain collaboration with suppliers. Notably, as business environments become more dynamic and unpredictable, buyers' trust in suppliers and their attitude toward cooperation, coordination, and communication with suppliers becomes more positive for boosting collaboration to overcome the uncertainty although business uncertainty increases uncertainty in supply chain agility.

Similar to business uncertainty, supply chain managers need to deal with supply chain disruption risk. Trust and supply chain collaboration consolidate supply chain relationships that play a positive role in mitigating supply chain risk [75]. Our research contributed to the literature envisaging that as perceived supply chain disruption risk increases, buyers' trust in suppliers and attitude for collaboration also increases as they want to overcome and mitigate disruption in supply chain risk. Thus, this research provides meaningful insights for supply chain disruption risk; managers rely on good supply chain relationships for strengthening trust and positive attitude for collaboration. However, supply chain disruption risk does not have significant relationships with efficacy in supply chain agility because managers' perception of dealing with supply chain disruption risk does not have a direct impact on their confidence in supply chain agility.

Like other applications of SCT in areas such as using computers, adopting innovation, and selecting a career, this study applies self-efficacy in the context of supply chain agility and finds that efficacy in supply chain agility has a positive impact on implementing supply chain agility as well as firm performance. In order to implement supply chain agility, firms need to educate the significance and need for supply chain agility in managing supply chains more effectively. In addition, managers' self-efficacy in supply chain agility is one of the success factors for implementing supply chain agility as it boosts the confidence levels of firms that have the capacity to deal quickly with unexpected events in the supply chain. Just as self-efficacy has a positive influence on computer learning and performance [29, 52], our research results confirm that self-efficacy in supply chain agility improves firm performance. Cognitive aspects of production system would help to adopt new technology and new business approach in the supply chain. More importantly, it gives confidence leading to successful operations in the supply chain networks. Thus, managers need to consider that improving self-efficacy in a supply chain results in successful implementation of supply chain agility and improves performance.

Trust has been receiving heightened attention in literature on supply chain relationships. Our results are consistent with most studies that provide empirical evidence on buyers' trust in supply chain relationships that generate a positive impact on supply chain agility as well as performance [54-58]. However, this study contributes that buyers' trust in suppliers is considered a significant cognitive antecedent for making decisions on implementing supply chain agility. Trust in suppliers is validated as a driving factor in decision making as it leads to the action of implementing supply chain agility from the buyers' perspective. In the context of trust and performance, buyers' trust in suppliers improves buyers' financial, operational, and supply chain performance, or complete firm performance, differentiating from prior literature which posits

that trust has a positive impact on only one dimension of performance, either financial or operational.

In supply chain management, trust is seen as a positive factor improving relationships, integration, agility, and performance. This research also provides consistent insights to supply chain managers suggesting that they need to find a way to establishing supply chain strategies to boost buyers' trust in suppliers so that it can lead an action of implementing supply chain agility and improve the overall buyers' performance. As a cognitive and affective factor, it is not easy to strengthen trust in suppliers. Frequent communication and information sharing can reinforce trust in suppliers. Supply chain managers' efforts to collaborate with suppliers improve trust.

Supply chain cooperation, coordination, and communication are empirically confirmed, and this illustrates the positive association between implementation of supply chain agility and firms' performance [1]. Thus, this research empirically confirmed that a positive attitude toward supply chain cooperation, coordination, and communication improves firm performance. This study contributes to the literature that a positive attitude toward supply chain practices can also play a significant role in improving buyers' performance instead of actual implementation. Firms need to consider educating managers about supply chain practices to boost the positive impact they can generate and provide managers clarity on such supply chain practices. Although information sharing improves supply chain agility [74], the positive attitude of supply chain cooperation, coordination, and communication is not a critical factor in decisions on implementing supply chain agility. With industry 4.0 technologies, decision making process will be improved [76]. In addition, supply chain collaboration would help to design product development process effectively (77).

Finally, supply chain agility implementation improves the firms' performance [1,6]. This research differentiates by measuring three dimensions: financial, operational, and supply chain performance. Implementation of supply chain agility is positively associated with the overall aspects of firm performance. Our study has some limitations due to the characteristics of empirical studies. First, this study applies the buyers' perspective in supply chain management practices. We collected the survey data from buyer firms by considering them as focal firms in a supply chain. This research targeted executives in supply and purchasing functions of buyer firms because they were knowledgeable and capable of answering all the survey questions to overcome this limitation. Second, our survey responses were collected from Korean manufacturing firms. Even though these companies have been doing business worldwide, geographical limitations continue to exist. In addition, future research can apply our research model in the context of service industries. Therefore, future studies could explore supply chain agility in the context of the U.S., China, or Europe or service industry by applying our research model to be tested. Finally, the future study would apply our research model in the context of Covid 19 situation that could generate severe supply disruptions risk as well as business uncertainty.

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## Appendix A

### Survey items and sources

<b>Business uncertainty</b>	<b>[16, 30]</b>
Range: strongly disagree-strongly agree (7 Likert scale)	
BU1	In your industry, growth in customer demand is dramatically increased.
BU2	In your industry, rate at which products and service become outdated is very rapid.
BU3	Market activities of your competitors have become more hostile.
BU4	In your industry, success depends on providing a large range of consumer tastes.
BU5	Our customers often change their order in a short period of time
BU6	Our plant uses core production technologies that often change.
<b>Supply chain disruption risk</b>	<b>[11, 39]</b>
Range: strongly disagree-strongly agree (7 Likert scale)	
SCR1	It is highly likely that our company will experience an interruption in the supply from our suppliers.

SCR2	We worry that our supplier may not supply the products following our purchasing agreement.
SCR3	Suppliers' inability to supply their products would jeopardize our business performance.
SCR4	An interruption of supplies from our suppliers would have severe negative financial consequences for our business.
SCR5	We recognize that supply chain disruptions are always looming.
SCR6	Supply chain disruptions show us where we can improve.
SCR7	Supply chain disruptions show us where we can improve.
<b>Supply chain agility self-efficacy</b>	
Range: strongly disagree-strongly agree (7 Likert scale)	
ASE1	We have a confidence on being able to changes in demand without overstocks or lost sales.
ASE2	We have a confidence on our supply chain being capable of responding to real market demand.
ASE3	We have a confidence on that our supply chain members recognize the importance of information integration.
ASE4	We have a confidence on that our supply chain members recognize the importance of joint planning on purchasing and production.
ASE5	We have a confidence on improving customer service as a high priority including delivery reliability
ASE6	We have a confidence on improving responsiveness to changing market needs as a high priority.
ASE7	We have a confidence that inventory and demand levels are visible through the supply chain.
ASE8	We have a confidence on detecting and responding the changes quickly in our business environments
ASE9	We have a confidence on identifying and making a definite decision toward opportunities in our business environments.
ASE10	We have a confidence on recognizing and dealing with threats swiftly in our business environments
ASE11	We have a confidence on adjusting our short-term capacity and orders whenever needed.
<b>Trust</b>	
Range: strongly disagree-strongly agree (7 Likert scale)	
TRU1	Our suppliers are trustworthy.
TRU2	Our suppliers have always been evenhanded in their negotiations with us.
TRU3	Our suppliers never use opportunities that arise to profits at our expense.
TRU4	When sharing our problems with suppliers, we know that they will respond with understandings.
TRU5	When it comes to things that are important to us, we can depend on our suppliers' supports.
TRU6	Whenever our suppliers give us advice on our business operations, we know that they are sharing their best judgement
<b>Supply chain cooperation, coordination and communication attitude</b>	
Range: strongly disagree-strongly agree (7 Likert scale)	
SCA1	We have a positive attitude on jointly implementing plans with our key supply chain members
SCA2	We have a positive attitude on coordinating our process and activities with our key supply chain members.
SCA3	There is a cooperative attitude on the relationship between our firm and other key supply chain members.
SCA4	Our supply chain members have a positive attitude on permitting each other to participate in strategic decisions.
SCA5	We have a positive attitude on exchanging information with our supply chain members.
SCA6	We have a positive attitude on exchanging information as soon as it becomes available.
<b>Supply chain agility implementation</b>	
[3, 4, 6]	

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Range: strongly disagree- strongly agree (7 Likert scale)	
SCAI1	We are able to changes in demand without overstocks or lost sales.
SCAI2	Our supply chain is capable of responding to real market demand.
SCAI3	Our supply chain members recognize the importance of information integration.
SCAI4	Our supply chain members recognize the importance of joint planning on purchasing and production.
SCAI5	Improving customer service is our firm's high priority including delivery reliability.
SCAI6	Improving responsiveness to changing market needs is our firm's high priority.
SCAI7	Inventory and demand levels are visible through the supply chain.
SCAI8	We detect and respond the changes quickly in our business environments.
SCAI9	We identify and make a definite decision toward opportunities in our business environments.
SCAI10	We recognize and deal with threats swiftly in our business environments.
SCAI11	We adjust our short-term capacity and orders whenever needed.
<b>Performance</b>	<b>[65, 66]</b>
Rate your firm's performance comparing with your industry average	
Range: very low-very high (7 Likert scale)	
FP1	Average return on investment
FP2	Average return on assets
FP3	Average income
FP4	Growth on market shares
OP1	Defect rate
OP2	Delivery reliability
OP3	Production and inventory cost
OP4	Lead time
SCP1	Ability to respond to and accommodate periods of poor supplier and delivery performance
SCP2	Ability to respond to and accommodate new products, new markets or new competitors
SCP3	Customer response time in supply chain
SCP4	Total cost of distribution and manufacturing

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