Supply Chain Readiness, Response and Recovery for Supply Chain Resilience to Vulnerabilities: A Study on Ready-Made Garment Industry of Bangladesh

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Abstract: In the contemporary world, supply chain resilience (SCR) has got an enormous importance among the academia and the business community. But research on supply chain resilience (SCR) is not substantial in number. Literature related to supply chain resilience measurement is even scarce. Most of the studies concentrate on capability and vulnerability to measure SCR. However, those studies are mostly conceptual in nature rather than empirical investigation. Empirical study to measure SCR incorporating supply chain readiness, response and recovery ability is quite absent. Upon existence of such void in the literature this study aims at developing a model of SCR measurement with reference to supply chain readiness, response and recovery in the context of ready-made garment (RMG) supply chain of Bangladesh. An exploratory field study utilizing an inductive methodology involving a multiple-case study approach has been undertaken. It is evident that a supply chain needs event readiness, and the ability to respond and recover quickly to be resilient. Measurement indicators with respect to supply chain readiness, response and recovery have been explored. The measurement items and their relationships are unique contribution of this paper. Further, the SCR measurement model will help the RMG supply chain managers to identify the degree of readiness, response and recovery ability.

Keywords: Supply chain, resilience, readiness, response, recovery.

Introduction

Supply chain resilience (SCR) is an issue of renewed focus because of the multiplicity of high impact vulnerabilities in the global supply chain. The susceptibility of thesevulnerabilities is increasing because of the growing complexity of supply chain operations.Vulnerabilities in the supply chain arise either from external sources such as natural, political and social or from internal sources (e.g. labour unrest) or from supply chain network (e.g. problem of cooperation among supply chain partners)(Jüttner, *et al.*[20]). Supply chainsneed to be more resilient to remain competitive and sustainable (Christopher and Lee [10]) in the outbreak of such vulnerabilities. In the case of occurrence of disrupttive events companies need to have high level of readiness and the ability of quick response and recovery (Christopher and Peck [11]; Ponomarov and Holcomb [27]). Otherwise, the consequence will be the discontinuity of supply chain operations which adversely affect both revenue and cost of the whole chain (Ponomarov and Holcomb [27]). Whilst supply chains are becoming more prone to vulnerabilities, the managers are facing more challenge to develop a readiness, quick response and recovery ability for a resilient supply chain. Similar types of challenges are intimidating the resilience of RMG supply chain of Bangladesh (Chowdhury *et al.* [2012]). RMG industry of Bangladesh, the major economic contributor of the country and one of the leading apparel exporters in the world, is frequently exposed to numerous types of social, political, operational disruptions. These disruptions are creating the whole supply chain vulnerable. Supply chain resilience is very crucial in the RMG supply chain to overcome the disruptions because resilience capability helps a supply chain to get back to original state from vulnerabilities (Pettit, *et al.* [26]; Christopher and Peck [11]).

Supply chains need to develop tangible and intangible capabilities to mitigate disruptions efficiently and effectively (Christopher and Peck [11], Pettit *et al.*, [26]). To do this, it is important to identify the degree of resilience needed by the supply chains. In this regard companies need to measure their supply chain resilience. But supply chain resilience measurement scale is yet to be developed (Ponomarov and Holcomb [27]). Some of the researchers (Pettit, *et al.* [26]; Christopher and Peck [11]; Sheffi and Rice [31]; Erol *et al.* [14])conceptually propose a number of sup-

ply chain capabilities such as flexibility, redundancy, collaboration, visibility, efficiency, responsiveness etc. and the vulnerabilities to measure SCR. But development of capabilities may not guarantee that a particular supply chain will be resilient. Suppose, a supply chain has capabilities but it may not quickly respond to a critical situation for example, the case of Ericson during fire in suppliers plant or it may not have sufficient readiness at a particular point of time and even may not recover soon. In this regard, the concept of readiness and time to respond and recovery has rightly been identified by the Ponomarov and Holcomb [27] and Yossi Sheffi [2005]. But they did not suggest indicators to measure readiness, response and recovery ability comprehensively as a surrogate to resilience measurement. In other disciplines for example, in Ecology (Holling [17]), disaster management (Bruneau *et al.* [7]) the concept of recovery time and readiness is widely used as a measure of resilience. Upon existence of such a void in the literature this paper aims to:

i) Formulate a model to measure supply chain resilience with respect to readiness, response and recovery.

The proposed SCR model will help the RMG manufacturers and suppliers to get ready, respond and recover in short time to be resilient and sustainable. The next section of the paper states the background literature followed by the research design, and findings. Then a comprehensive research model is depicted. The concluding part of this paper includes discussion and implications, limitations and conclusion.

Research Background

RMG industry is an economic propeller of Bangladesh, accounts for 76% of total export earnings and over 2.5 million direct employments of which 80% are women. Moreover, the industry has grown from 31.57 million US dollar business in 1983 to 10699.8 million US dollar during 2008 (BGMEA report 2007-2008). Bangladesh is considered one of the leading exporters of RMG in the world. Because of enormous economic importance in the economy of Bangladesh long term sustainability in RMG supply chain is necessary. Besides, the RMG supply chain is facing a climax situation owing to numerous challenges such as labour unrest for violation of human rights, poor wages, hazardous working environment, political instability, interruption in utility supply especially power shortage, inefficiency in customs and port management, exchange rate fluctuation, warehousing problem, disruption in supply of fabrics and other accessories in time, increased competition, inefficiency in operation, intensive competitive pressure from China and India, strict compliance code regarding social and environmental issues demanded by the buyers, environmental pollution (Islam and Deegan [2008], Chowdhury *et al.* [2012], Haider [16]. Further, increased lead time and cost due to disruptions in procurement and shipment of goods (Nuruzzaman [24]) lack of linkages and co-ordination among related industries in the value chain and dependence on imported inputs and limited variety of finished products (Quashem [2002]; Ahmed [2011]), fall of order because of global economic downturn (Chowdhury*et al.* [2012]) are issues of high concern for the RMG supply chain of Bangladesh. In such a situation it is crucial to find ways and means to make RMG supply chain resilient and sustainable. Previous researchers focused mainly on RMG competitiveness, the existing problems of the industry, violation of social issues, and status of sustainability reporting practices in the industry. Till now a model of supply chain resilience (SCR) and SCR measurement scale for RMG industry of Bangladesh have not been explored. In this theoretical lacuna the researchers are motivated to conduct the underlying research.

Literature Review

Supply Chain Resilience

Resilience is multidimensional and multidisciplinary. Ecological scientist Holling [17] was one of the first researchers to introduce the concept of resilience. To Holling a system has two properties: resilience and stability. Resilience is ability of systems to absorb changes and stability is the capacity of a system to get back to equilibrium state after disturbance. In ecological science (Carpenter *et al.* [9]) has given a comprehensive idea about resilience stating that resilience is the amount of change that a system can absorb and capable of organizing itself without losing control and the capacity to learn and adapt in response to disturbances. Similarly resilience has been popularly used in other non-business fields such as engineering, sociology, psychology, disaster management and other areas. In organizational perspective resilience has been explained in terms of adjustment of capabilities of organizations such as adaptability, flexibility, maintenance, and recovery to mitigate disruptions (Ponomarov and Holcomb, [27]). Resilience in supply chain management is derived from risk management literature and resilience is one of the core elements of supply chain risk management. In supply chain management (Svensson [32]) states resilience as unexpected deviations from the supply chain vulnerabilities. Christopher and Peck [11] entail resilience as the ability of a supply chain to return to its original state

or move to a better state after disruption. Taking multi-disciplinary concepts Ponomarov and Holcomb [27] explained supply chain resilience in a wider aspect as "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function." Most of the literature regarding supply chain resilience, focus on the aspect of supply chain capabilities to mitigate vulnerability. Apart from the capability and vulnerability issues, some of the writers (Ponomarov and Holcomv, [27], Sheffi and Rice, [31]; Falaska *et al.*, [2008]) introduced the concept of supply chain readiness, response time and recovery time to explain supply chain resilience. In the light of above discussions it can be remarked that supply chain resilience is a multidimensional higher order construct which can be measured not only in terms of capability and vulnerability rather the aspects of supply chain readiness, response and recovery time shall be considered.

Supply Chain Vulnerability

The uncertainties and disruptions often make the supply chain vulnerable. Supply chain vulnerability is the susceptibility of a supply chain to disruptions arising from internal or external sources (Christopher and Peck, [11]). Vulnerability of an event is high when both likelihood and impact of disruption are high. On the other hand disruptions with low probability and less consequence have low vulnerability (Sheffi and Rice, [31]). The experience of disruptions may take different forms such as delay during transportation, port stoppages, frequent occurrence of natural disasters, weak communication, supply shortages, Demand volatility, quality problem, operational issues and terrorism are few among the lot (Colicchia, *et al.* [12]), Kleindorfoer and Saad [21], Blackhurst, *et al.* [5]). Kleindorfer and Saad [21] classified three main categories of supply chain disruption: firstly, operational disruption which envelops equipment malfunctions and systemic failures, abrupt discontinuity of supply, bankruptcy, fraud, or labor strikes; secondly, natural hazards which include earthquakes, hurricanes, storms; and thirdly, terrorism or political instability. (Blos *et al.* [6]) entail four major sources of supply chain vulnerability such as financial vulnerability, strategic vulnerability, hazard vulnerability, operations vulnerability. Chirstopher and Peck, [11], mention the vulnerability with regards to process and control as internal and demand, supply and environmental vulnerability as external. Kleindorfer and Saad, [21] discuss vulnerabilities arising from operational risks such as equipment malfunctions, unforeseen discontinuities in supply, human centred issues from strikes to fraud and hazard risk such as natural hazards, terrorism, and political instability. Sheffi and Rice [31] highlight two types of vulnerabilities that occur due to random events such as natural disaster or accidents and intentional disruptions such as sabotage terrorism etc. (Juttner [18]) classifies three types of supply chain vulnerabilities: demand, supply and environmental. (Wagner and Bode [34]) enumerate three types of supply chain vulnerabilities namely: demand side, supply side and catastrophic. Blackhurst *et al.*, [5], identify a large number of contemporary supply chain disruptions under the classification of internal and external disruptions which further classified to the category of disaster, logistical, supplier, quality, information, forecasting, procurement, legal, shortage of capacity and inventory risk. Through Blackhurst *et al.*, [5], include a robust list of disrupttion risks they have not include some important disruptions such as disruptions arising from buyers' side or down disruptions. Colicchia *et al.*, [12] state vulnerabilities related to international transporttation process that includes travel, port and operation related vulnerabilities. (Wu *et al.*[36]) describe inbound supply chain disruptions as internal: controllable, partial controllable, and uncontrollable and external: controllable, partial controllable, uncontrollable. Pettit *et al.*, [26] consolidated thirty nine disruptive issues to seven factors: turbulence, deliberate threats, resource limits, sensitivity, connectivity and supplier/customer disruptions to measure supply chain resilience. In the light of above literature it can be summarized that a wide number of researchers mentioned about different types of vulnerabilities to measure supply chain resilience, but existence of vulnerability does not indicate that it is less resilient. Rather, resilience of a supply chain depends on impact of vulnerability (Jüttner and Maklan [19]). Therefore, we measure the resilience based on impact of vulnerability to specific situation.

Supply Chain Readiness

Supply chain managers need to be proactive to get readiness for mitigating the disruptions (Peck [25]). The goal of preparedness is to prevent probable disruptions or reduce the impact of loss from vulnerabilities. Supply chains with high level of readiness can take alternative arrangements to reduce vulnerabilities as a supply chain needs event readiness to be resilient (Ponomarov and Holcomb, [27]). A supply chain needs to forecast, identify risk, monitor deviation, early warning signal to anticipate and prepare for mitigating disruptions (Pettit, *et al.* [26]). Moreover, preparation for recovery can be taken in advance if the disaster can be forecasted (Sheffi and Rice [31]). Correct forecasting help organizations and supply chains to identify risks in a timely manner.

Risk identification helps to know the sources of risk (Christopher and Peck, [11]) as a result one can take preparation against the disrupttions. Along with forecasting, monitoring risk an early warning signal analysis is important in the sense that advance information can be obtained about the likelihood of disruptions. Such proactive capabilities are needed to overcome uncertainties of business environments (Aragón-Correa and Sharma [1]) which in essence help to develop the resilience capability of an organization and supply chain (Christopher and Peck [11]). Based on the above literature it can be proposed that

P1: Supply chains with higher readiness are more resilient.

Supply Chain Response and Recovery

To Sheffi and Rice [31] ability of supply chain to respond quickly to market needs and to the disaster is an important determinant of supply chain resilience. A company can also achieve competetiveness by its quick response ability. A late response to disaster may cost several hundreds of million dollars to companies and supply chains. For example, a late response and lack of readiness during fire in the supplier's plant of Erricson in Mexico created shortage of radio-frequency chip supply which later on accounted for a huge loss of $400 million (Norrman [23]). On the other hand, a quick response from Nokia after the occurrence of fire in the same supplier's plant helped Nokia to overcome the disruption of supply shortage of chip and to gain competitive advantage (Sheffi and Rice, [31]). Therefore, ability of a supply chain to respond quickly can be considered as an important determinant of supply chain resilience.

Recovery from disruption is a critical and unique ability of organizations and supply chains. Some systems whether it is a business network, ecological system or a nation, can quickly recover from the disaster. This sort of recovery ability exposes the resilience ability of the system. In literature, resilience is mostly measured in terms of recovery time (Sheffi and Rice [31]; Christopher and Peck, [11]; Ponomarov and Hollcomb, [27]; Gunderson, [2001]). Again it is important to consider the effort and cost of recovery. Martin [2004] included cost as a parameter to measure resilience. Similarly, other researchers such as (Vugrin *et al.* [33])considered cost as an important factor for resilience. A system may get recovery with in less time (Wang *et al.* [2010]), effort and cost (Vugrin *et al.* [33])because of the efficiency and unique ability of absorbing shock (Holling [17]) or reducing the impact of disruption (Rose [29]) or inherent ability to return original position (Christopher and Peck [11]). Therefore, resilience can be measured by the extent of recovery time, cost, absorption of disruption and ability to reduce the impact of loss. If the time and cost of recovery is high resilience is low and vice versa. On the other hand, if a system can absorb huge disruption or can reduce the impact of loss compared to the estimation, the system is deemed to have higher resilience and vice versa.Based on the above support it can be proposed that

P2: Supply chains with higher response and recovery ability are more resilient.

Conceptual Framework from Theoretical Lens

The resource-based view (RBV) argues that firms achieve sustainable competitive advantages by deploying the bundle of resources and capabilities which are unique and internal to the firms (Wernerfelt [35], Barney[2,3],Grant[15]). Wernerfelt [35] argues that resource means anything that can be considered as strength of a firm. It may be tangible such as financial reserves, plant and machinery, equipment, and stocks of raw materials, and other physical assets or intangible such as brand names, in-house knowledge of technology, skilled and trained human resources, managerial capabilities, organizational culture, social relationship, reputation, trade contacts, effective and efficient processes, etc. (Wernerfelt [35]; Grant [15]; Barney [2]).

In an environment of uncertainty and disruptions organizations can be successful in the competition by overcoming threats and uncertainties effectively (Wernerfelt [35]). Studies have shown that effective capabilities vary with market dynamism and business environment (Eisenhardt and Martin [13]); (Brush and Artz [8]). Researchers of the RBV advocated for inclusion of the ability to overcome disruption and contingency as organizational resources and capabilities (Barney [4], Prien and Butler [28]. Aragón-Correa and Sharma [1] in their "contingent resource based view (C-RBV) of proactive corporate environmental strategy" argue that organization's proactive environmental attempt to mitigate environmental uncertainties and complexities is a valuable dynamic capability of a firm. They also argue that firms need to invest in achieving tangible and intangible resources for developing capabilities to overcome uncertainties of business environments. In the literature this sort of resource and ability is termed as resilience. Such resources and capabilities are needed in the context of RMG supply chain of Bangladesh as it is facing numerous disruptions from different environmental factors (Haider [16]). Integrating natural resource based view (N-Rbv) and stakeholder theory (Markley and Davis [22]) advocate the need for capability to mitigate and reduce the environmental uncertainties

in supply chain to reduce negative environmental and social vulnerabilities. This study presumes that this type of resilience capability is needed for supply chain readiness, response and recovery from vulnerabilities in the context of RMG industry of Bangladesh.

Research Method

The field study has been conducted by employing qualitative method as the research paradigm (Zikmund, [2003]). A semi-structured interview approach has been adopted in this regard so that the researcher may better understand the pros and cons of the research area. The review of the literature has provided the framework for initial development of the interview questions. The literature also helped in refining the interview questions so that it fits better to the actual situation. Interview has been proven to be a very common and effective method in obtaining qualitative data (Whiteley *et al.*, [1998]). Once the method of collecting data is selected, it is obvious to select the samples. Like any other research method, field study also involves selecting samples from the population under study either through random or non-random method (Zikmund, [2003]). The sampling method used for this study is a convenience non-random type.

Sample Selection

The interview participants have been selected based on four main criteria; one: the position of the participants, two: the industry in which their organisations belong to and three: which supply chain function (manufacturing and material suppliers) are they performing and four: the size of the company. Fifteen managers from middle and top management hierarchy have been chosen for interview. The supply chain managers and the persons dealing with supply chain functions of the organization where there is no supply chain manager have given priority for sample selection. The selection of all interviewees was based on personal contacts. Therefore, nonprobability sampling or convenience sampling is employed in this regard (Babbie [1990]). Moreover, this technique provides the means to approach the participants more conveniently (Cavana, *et al.* [2001]). Table 1 illustrates the demographic information of the interview participants and the organisations they are affiliated with.

Data Collection and Recording

Once the sample selection is determined the interviewees were approached through telephone to take their interview schedule and eventually to participate in the field study. The response was encouraging as 15 of them out of eighteen have been agreed to participate in interview. The interviews were recorded with the permission of the participants and notes were taken throughout the interview. The interview duration was one hour and fifteen minutes on an average. The data were transcribed immediately after interview so that the senses and tunes of the interview are reflected properly.

Data Analysis

For performing the task of qualitative data authors for example, Miles and Huberman [1994] suggest a number of techniques. Content analysis is a useful technique in this regard. In this research for analysis of the collected data from field study, content analysis has been used. From the content analysis the relationship between different constructs are explored. Moreover, content analysis involves the examination of data in a systematic and replicable fashion (Wilkinson [2000]). It is a good technique and widely applied in previous research for example, Xu and Quaddus [2005] employed it to examine the applicability of the qualitative data to transform into

Table 1. Participants description

Participant	Position	Company type	Company size (number of employees)	Age of company
D1	Manager merchandising	RMG manufacturer	2000-3000	10-15
D2	Supply chain manager	Supplier	Less than 1000	5-10
D3	Manager Merchandising	RMG manufacturer	1000-2000	0-5
D4	General manager	RMG manufacturer	More than 4000	5-10
D5	Managing director	RMG manufacturer	1000-2000	5-10
D6	Supply chain manager	RMG manufacturer	More than 4000	20-25
D7	General manager	RMG manufacturer	2000-3000	20-25
D8	Supply chain manager	RMG manufacturer	More than 10000	20-25
D9	Manager Merchandising	RMG manufacturer	3000-4000	5-10
D10	Supply chain manager	Supplier	Less than 1000	5- 10
D11	Deputy general manager	RMG manufacturer	More than 20000	25-30
D12	General manager	Supplier	Less than 1000	0-5
D13	Deputy general manager	Supplier	Less than 1000	10-15
D14	Deputy general manager	Supplier	Less than 1000	15-20
D15	Manager merchandising	RMG manufacturer	Less than 1000	10-15

quantitative data for statistical analysis. NVIVO-9 software program has been used to facilitate the data analysis process as it is a useful tool for searching, linking and exploring the pattern of data and ideas (Richard, [1999], p.4). According to Siltaoja [2006], the method of content analysis "can be used in a number of ways". This study uses the two-steps process of inductive and deductive analysis (Berg [1989]) to scan and endorse the themes and sub-themes from the raw data to fulfil the objective of the exploratory study.

The 1st step of analysis is the inductive phase. This phase consist of exploring themes, sub-themes, factors, sub factors and variables. It involves open coding, axial coding and selective coding (Cavana, *et al.* [2001], Neuman [1997]). The interview contents coded very carefully and a number of free nodes were identified containing individual concepts. Afterward tree nodes were developed from a set of relevant free nodes having similar concept. For example when respondents were asked about supply chain readiness, response and recovery 19 free nodes (variables) were explored. Combining the similar variable into one, 10 variables have been identified. Then, those variables were grouped into two nodes, named as "supply chain readiness", and "response and recovery".

Each tree node thus considered prospective constructs. The findings are frequently reviewed and checked time and again to ensure reliability. It also helps to double check whether any theme or sub-theme has been missed or even the classification has been appropriately done.

After inductive stage of content analysis, the deductive phase starts. In this stage, the findings of the field study are justified based on literature review to finalise the constructs. Eventually, a comprehensive research model for this study is developed which is shown in Figure 1.

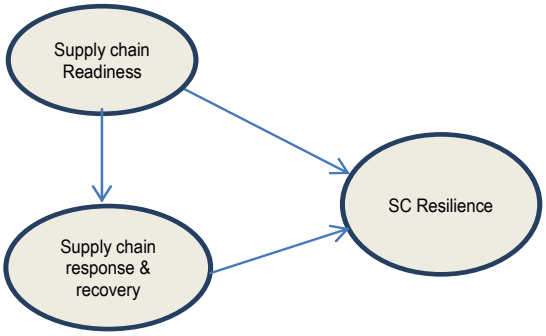

Figure 1. Proposed model

Findings

From the content analysis it revealed that the RMG supply chain of Bangladesh is often vulnerable to different disruptions. These sorts of vulnerabilities hamper, to a large extent, in meeting lead time, proper quality, and achieving the desired goal for example, participant 5 stated *"that last year during this season we got lot of sales order from the buyers but this year we are far behind our expectation."* On the other hand, some companies are not much affected by vulnerabilities.

To mitigate the vulnerabilities, organizations need some capabilities and all the participants in the field study agreed that they need capabilities to prepare themselves, respond quickly and recover quickly from vulnerabilities. To them in garment business quick response is very important and therefore, they always need readiness to respond quickly. Participant 11 for example, quoted that *"sometimes buyers request us some extra quantity because of over demand. In that situation we need to respond quickly otherwise buyers cannot meet the market demand."* A deeper and detailed idea regarding the determinants of RMG supply chain resilience is shown in Table 2.

Readiness

Supply chain readiness is important to minimize the impact of disruptions. Readiness is important in the sense that one may have resources but may not have readiness to use it during crisis. A prior information and forecasting about disruptions help to take alternative preparation in advance. It is revealed that about 40% of the respondents told that they have readiness to mitigate vulnerabilities and. In line with this, capabilities such as Preparation to overcome disruptions, forecasting, early warning signals, and security system and alertness are important according to the respondents. Forecasting is very important RMG suppliers. They need to forecast in advance because their demand is derived from RMGs. The lead time of RMGs is short as a result the suppliers need to supply material with in very limited lead time. Suppliers also depend on imported raw material as a result they need a long procurement time. To supply with in the limited time and to respond to sudden demand of the RMGs, a good forecasting is very important otherwise, demand cannot be met in time. Regarding forecasting participant 2 stated that *"…we need to forecast at least two- three months in advance…."* Regarding preparedness respondent 8 illustrated that *"In every month we have fire drilling and checking fire equipment….."* Regarding readiness-participant 6 illustrated that *"We are very big and we have preparation for any uncertainty. {….} If we have hurry regarding a particular buyer's order we can tell some lines to engage for that from another work because they are trained in that way."*

Table 2. Factors and variables of supply chain resilience

Factors	Variables	Enterprises														
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Readiness	Readiness training and inspection (rehearsal, checking electrical and fire equipment)		y				y		y	y		y		y	y	
	Availability and accessibility of disruption mitigation resources		y					y		y		y	y			
	Forecasting		y	y			y		y	y	y					
	strong security system and alertness		y		y		y		y	y	y					
	Analysing early warning signals		y		y		y		y	y						
Response & recovery	Response time		y		y		y		y	y	y	y		y		
	Recovery time	y		y	y		y		y	y	y	y	y	y		
	Impact reduction		y		y		y		y		y					
	Recovery cost			y					y	y						
	Cost and loss absorption capacity		y						y			y		y		

Table 3. Relationship between supply chain readiness and response, recovery

Relationship	Enterprises														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Supply chain readiness → response & recovery time	y	y	-	y	-	y	-	y	-	y	-	-	y	-	-

Response and Recovery

It is evident that Supply chains need to have quick response and efficient recovery ability to mitigate the existing or potential vulnerabilities. Quick response and recovery is important in because one may have resources but may not respond and recover quickly.

Quick response is very crucial during critical situation. A little late in response may account for many million dollar loss for example, loss of Erickson after fire in supplier's plant (Norrman and Jansson, [23]). The respondents also expressed their opinion regarding the importance of quick response and 8 out of 15 respondents supported the capability of quick response. Referring to it participant 11 mentioned that *"if there is a sudden declaration of strike during shipment time we finish everything very quickly and overnight to send the products in port before strike."*

Both recovery time and cost are considered important determinant for resilience as per the opinion of respondents. Ten respondents out of fifteen confirmed about the importance of quick recovery. On the other hand, only three respondents supported the need for less recovery cost for being resilient. Regarding recovery time participant 13 for example reported that *"we are resilient because we can recover very quickly even in case of any accident by our experience and financial ability."* Referring to recovery cost participant 2 quoted that *"We have high resilience because we can recover from vulnerability efficiently and at less cost due to our skilled people and preparedness."*

Relationship between Supply Chain Readiness and Response, Recovery

Another explored relationship among the resilience factor is supply chain readiness and response and recovery (see Table 3). 7 out of 15 respondents agreed about the relationship. Participant 13 for example, stated that *"….we can respond very quickly in case of any accident because we have safety training and inspection."* In line with this participant 2 illustrated that *"….we can recover from vulnerability efficiently and at less cost due to our skilled people and preparedness."*

Discussions and Implications

Theoretical Implications

This study establishes a model of supply chain resilience (SCR) based on Resource based view and relevant literature (see Figure 1). As resource based view (RBV) asserts the importance of unique resources and capabilities for organizations. The proposed model also advocates the importance of resilience capability with regards to supply chain readiness, response and recovery.Using a multi-dimensional aspect the findings of this study present a model for measuring SCR. Such model is unique for the organizations and supply chains during the event of crisis.

Table 4. Justification of the extracted factors and variables from literature

Factors	Variable	References
Readiness	Readiness training and inspection	Sheffi and Rice[31]; Pettit *et al.* [26]; Rousaki and Alcott [30]
	Availability and accessibility of disruption mitigation resources	Rousaki and Alcott [30]
	Analysing early warning signal	Pettit *et al.* [26]
	Good forecasting ability	Pettit *et al.* [26]; Cranfield [2002, 2003]; Peck [25]; Sheffi [31], Blackhurst *et al.* [5]
	Security system/alertness	Peck [25]; Sheffi [31], Rice and Caniato [2003]; Craighead *et al.* [2007]
Response and Recovery	Less response time	Sheffi and Rice [31]; Norrman and Jansson [23]
	Less recovery time	Sheffi and Rice [31]; Christopher and Peck, [11]; Ponomarov and Hollcomb, [27]; Gunderson,[2000]
	Loss absorption/impact tolerance	Holling, [17]
	Less recovery cost	Martin, [2004]; Vugrin *et al.*[33]
	Reduction of impact	Rose [29]

An important relationship between supply chain readiness and response and recovery has been explored. It implies that a high level of supply chain readiness is needed for quick response and quick recovery from crisis. The research model developed from this study can be taken as a research model for proposition development and further empirical investigation. Further research is required to develop appropriate research hypotheses to carry on with the above research. The researchers plan to examine this model further using structural equation modelling (Barclay *et al.*, [1995]) to test a number of hypotheses.

Managerial Implications

In terms of managerial implications, the SCRmodel shows the determinants of supply chain readiness, response and recovery for developing aresilient RMG supply chain in Bangladesh. It will help the RMG supply chain managers to identify the degree of readiness, response and recovery ability. They can also understand the nature of relationships among the resilience determinants and how they influence each other. The RMG supply chain managers may make strategic and operational planning based on the Resilience measurement index for each determinant. It will consequently help them to overcome the existing challenges prevailing in RMG industry and help them to be resilient and sustainable in the long term.

Limitations and Directions for Further Research

Our study has some limitations which open opportunities for further research. Limitations of this study are inherent firstly, in the chosen method of conducting the study. The study is based on case study which needs an empirical verification by survey research to prove the external validityof the SCR model developed in this research. The researchers attempt to further examine the comprehensive SCR model by taking quantitative research method through empirical surveys. Structural equation modelling (Barclay *et al.*, [1995]) will be used to test the relevant proposed hypotheses.

Conclusions

This study uses multiple-case method to identify the factors, and variables for a SCR model in the context of RMG industry of Bangladesh. An extensive research model was developed on the basis of the conceptual framework and using the data collected from 15 decision makers in the field of supply chain management from 15 RMG manufacturers and their suppliers. The interviews were transcribed by the researchers, and the contents were analysed using content analysis approach. As many as twofactors and tenvariables regarding RMG supply chain readiness, response and recovery are explored from the interviews which are justified by the literature for developing the comprehensive model. The proposed model suggests that in order to be resilient, the RMG supply chain members need to reduce the impact of vulnerabilities by developing a certain level of readiness and reducing the response and recovery time. It reveals that there are relationships between supply chain readiness and response and recovery. So, RMG supply chain members need to manage the determinants of SCR and their dynamic relationships to be resilient.

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