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Business continuity, disaster readiness and performance in COVID-19 outbreak aftermath: A survey

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Abstract: Anchored in the COVID-19 context, this research seeks to examine the role of business continuity practices in improving both disaster readiness and business performance. A survey of 322 French firms was conducted and data were analyzed using structural equation modelling. The findings corroborate the postulates of resource-based view and organizational information processing theories regarding business continuity practices in COVID-19 context. Firms that improve their disaster readiness ($B=.243$; p -value=.008**) and their business continuity practices ($B=.173$; p -value=.038*) are more capable of enhancing their performance. The findings raise some questions regarding the validity of the preexisting knowledge on business continuity and disaster readiness in the context of COVID-19.

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Keywords: Business continuity, COVID-19, pandemic, financial performance, disaster readiness.

1. INTRODUCTION

Business continuity (BC) practices comprise the measures taken by firms to anticipate, mitigate and control the negative impacts of supply chain (SC) disruptions (Aza degan et al., 2020). In the context of SCs volatile environment, firms deploy BC measures of risk detection, mitigation, continuity planning, emergency response and recovery (Ambulkar et al., 2015; Azadegan et al., 2020). The context of COVID-19 disruption impacts provides an appropriate opportunity to investigate BC practices of firms and how they deploy different measures to deal with such disaster. Given the global impacts on supply, production and distribution activities and their unprecedented magnitude, many professional reports focus on the consequences of the pandemic crisis (Ivanov, 2020). Consequently, several scholars call for further investigation to elucidate how firms might develop survival mechanisms to mitigate COVID-19 impacts (Ivanov and Dolgui, 2020; Ivanov, 2021).

BC practices have been extensively examined as measures to cope with threats and disruptions impacts under the umbrella of supply chain risk management (e.g., Kern et al., 2012; Wieland and Wallenburg, 2012). Notwithstanding, the outcomes of BC practices on both of firms' disaster readiness and performance have not been sufficiently examined (Aza degan et al., 2020). SC disaster readiness is a pre-emptive SC capability which aims at reducing the likelihood and the impact of disasters by anticipating them (Stone and Rahimifard, 2018) thanks to knowledge, experience and collaboration (Richey, 2009; Forbes and Wilson, 2018). It is interdependent to response and recovery from a disaster (Scholten et al., 2019) which was also highlighted in the COVID-19 pandemic context (Scala and Lindsay, 2021). Indeed, readiness is an utmost important SC capability when SCs face large-scale disasters and such readiness may be

linked to the elaboration of BC programs (Forbes and Wilson, 2018).

There is a need to investigate how firms might deploy BC programs to cope with the challenges of the current COVID-19 outbreak and to what extent can such processes help firms improve their readiness and performance. This study argues that firms with disruption readiness resulting from their experience and survival from previous disruptions can significantly improve their financial performance in a 'super disruptions' context (Ruel et al., 2021).

This research is based on two theoretical frameworks: the organizational information processing (OIP) theory and the resource-based view (RBV). A quantitative approach was adopted on survey data collected from 322 French SC professionals using square structural equation modelling (SEM).

2. THEORETICAL BACKGROUND

2.1 Resource based view and dynamic capabilities

The RBV was developed as a response to the uncertainty in the business environment (Barney, 1991). According to RBV, firms can achieve sustained competitive advantage if they possess valuable, inimitable, and non-substitutable resources (Barney, 1991). Despite its popularity, RBV was criticized for the ambiguity of the resources' concept and its static approach (Priem and Butler, 2001 a, b) which limits its explanatory and operational scope. In response, the concept of dynamic capabilities has been developed to reflect the dynamic challenges faced by firms (Winter, 2003). Dynamic capabilities are a response to analyses of competitive intensity in a changing environment (Teece et al., 1997).

Beyond firm's boundaries, several scholars conceptualize dynamic SC capabilities to investigate how SC partners can

mobilize cross-organizational processes to create and/or modify capabilities in alignment with market shifts (Aslam et al., 2020). Regarding BC practices, RBV constitute a relevant framework to examine how firms might coordinate their processes as dynamic capabilities to mitigate SC risks (Pereira et al., 2014; Chowdhury and Quaddus, 2017). Firms need to restructure and realign their resources and processes (Ambulkar et al., 2015; DuHadway et al., 2019) to quickly adapt and respond to changes resulting from the disruption. Disaster readiness can be considered as dynamic capabilities and resources (Norris et al., 2008) required by firms in extreme situations to decrease ambiguity by better processing information and thus maintain business performance (Ivanov and Dolgui, 2020). This is the reason why we combine RBV with OIP theory which highlights the need to decrease ambiguity to cope with uncertainties.

2.2 Organizational information processing theory

OIP theory is relevant to understand how firms may manage their SCs in a turbulent environment that may lead to disruptions (DuHadway et al., 2019). Galbraith (1974) suggests that firms should develop capabilities to meet increasing requirements for information processing due to mounting uncertainty, ambiguity, and equivocality. For a firm, developing its information processing ability is a way to better deal with uncertainty (Wu et al., 2013). SC disruptions generates uncertainty due to the amount of information to be collected, treated, and interpreted (Wu et al., 2013). Consequently, processing information becomes indispensable for designing SC risk practices (DuHadway et al., 2019). Furthermore, the level of uncertainty parallels the magnitude of SC disruptions. Therefore, firms need to build structural practices to meet the information processing requirements (Bode et al., 2011) generated by increased uncertainty. Organizations who successfully build these capabilities can enhance their competitiveness and performance (Carnovale and Yeniyurt, 2015; Wu et al., 2013).

OIP tenets can be applied at the SC level, since information processing capabilities can improve the ability of firms to manage their network and boundary spanning (Hult et al., 2004; Carnovale and Yeniyurt, 2015). OIP constitutes an adequate framework to examine SC disruptions and BC practices by highlighting how firms formalize processes to gather and interpret information which can lead to enhance preparedness and mitigate disruptions impacts. In the COVID-19 context, the ability of firms to reconfigure their capabilities is crucial for their survival (Ivanov and Dolgui, 2021). Along the lines of several research studies (e.g., Chowdhury and Quaddus, 2017), we argue that firms who can restructure and redeploy their resources in a turbulent environment also succeed in developing capabilities that mitigate SC disruptions impacts. By proactively configuring and managing resources, i.e., BC practices, firms can mitigate SC disruptions and therefore might succeed in recovering their performance after having absorbed the disruption effects.

3. HYPOTHESES DEVELOPMENT

3.1 Business continuity practices, disaster readiness and the effects of Covid-19

BC practices aim at mitigating disruptions impacts (DuHadway et al., 2019; Azadegan et al., 2020) and limiting the effects of SC disruptions (Bode et al., 2011; Chowdhury and Quaddus, 2017). Facing the various threats of disruptive events, firms tend to develop specific BC practices including risk identification, assessment, mitigation, and control.

Drawing on prior research (Bode et al., 2011; Ambulkar et al., 2015; Chowdhury and Quaddus, 2017), we mobilize the concept of disaster readiness to underline the experience and knowledge (Richey, 2009; Forbes and Wilson, 2018) acquired by firms who restructure their resources to face disruptions. Thus, according to Ambulkar et al. (2015), firms facing disruptions and disaster often develop a SC disruption orientation or alertness that can be used in future situations. Hence, firms who have already faced disasters learn how to be alert, train their employees to be ready, deploy forecasting and ensure that there are early warnings for SC disruptions (Chowdhury and Quaddus, 2017). Disaster readiness reflects firms' preparedness resulting from prior experience in dealing with man-made or natural disasters (Ambulkar et al., 2015; Bode et al., 2011; Chowdhury and Quaddus, 2017). BC practices can be conceptualized as resources/capabilities to be configured and reorganized proactively. In this respect, the more experienced firms in terms of BC programs the more they acquire disaster readiness (Forbes and Wilson, 2018). Specifically, the more time spent identifying and assessing risks and past disruptions the better firms' responsiveness becomes (Ambulkar et al., 2015). Finally, a recent qualitative research (Scala and Lindsay, 2021) has suggested that a BC program could support disaster readiness in a pandemic context, but this statement requires further validation. BC practices are different from disaster readiness. More specifically, disaster readiness is seen in the literature as a dynamic capability (Norris et al., 2008) or sometimes as a mindset or even a people-centred philosophy (Su et al., 2021) while BC practices are mainly processes based on tools and strategies (Chowdhury and Quaddus, 2017; Kern et al., 2012; Wieland and Wallenburg, 2012).

H1. Business continuity practices can significantly influence firms' disaster readiness to COVID-19 outbreak.

The COVID-19 disrupted the global economy by paralyzing several industries (Ivanov, 2020), creating supply shortages and difficulties to meet customers' requirements. Margherita and Heikkilä (2021) suggest that firms had difficulties in managing the disruptions by relying on BC programs. In addition, Su et al. (2021) imply that disaster readiness is impacted by COVID-19 damage.

H2.a COVID-19 damage can significantly affect firms' business continuity practices; and their H2.b disaster readiness.

3.2 Business continuity practices, disaster readiness and business performance

BC practices aim to foster BC by reducing exposure to threats which entails prioritizing risks according to their probability and impacts including loss or waste of opportunities (Azadegan et al., 2020). By assessing the criticality of risks and processes, firms can decide how to better manage their resources which help eliminate waste and redundancy. However, firms need to learn how to realign and reconfigure their resources to mitigate disruption threats (Ambulkar et al., 2015). Such ability to reconfigure resources has been demonstrated in numerous studies to be effective in influencing firms' performance (e.g., Ambulkar et al., 2015). Consequently, BC practices enable firms to avoid unnecessary focus on developing useless operations. BC enables firms to place more emphasis on personnel efforts that increase cost efficiencies and improve their performance (Azadegan et al., 2020; Wieland and Wallenburg, 2012). Business performance of a company may refer to different areas of outcomes, e.g., financial, operational, and social. In this research, we focus on financial performance aspects that have been investigated in numerous studies related to BC outcomes (Azadegan et al., 2020; Kroes and Gosh, 2010; Wieland and Wallenburg, 2012).

H3. Firm's financial performance is influenced positively by business continuity practices.

Because disaster readiness measures preparedness to disruptions, it suggests that firms having a acquired experience in dealing with disruptions might reduce the negative impacts stemming from such events (Ambulkar et al., 2015; Bode et al., 2011; Chowdhury and Quaddus, 2017) including costs. So, disaster readiness reduces firms' costs and enhances their capability to exploit business opportunities. Thus, disaster readiness might affect performance.

H4. Firm's financial performance is influenced positively by disaster readiness.

4. METHODOLOGY

A survey was designed. After a survey pre-test from practitioners, data were collected from randomly selected French firms (3570). We obtained 322 complete responses. G*Power tool indicates that with a minimum R^2 value of 0.10, a statistical power of 80%, and two predictors (SC risk practices and disaster readiness) a sample size of minimum 74 is required.

To assess the potential of non-response bias, we performed a comparison between early and late respondents. Levene and Student T-tests were calculated for the groups of early and late respondents (N=80 and N=70) on all variables, and we found that no difference was significant in terms of firm sector, age, annual sales and size ($p > 0.1$). Therefore, non-response bias does not constitute an issue in this study. Finally, we assessed the common method bias (CMB) through several methods. One example is that we compared the fit between the one-factor model and the measurement model to assess CMB. The results reveal a weak fit of the one-factor model ($\chi^2=2533.91$, $df=224$, $p > 0.01$) which is inferior to the fit of the measurement model ($\chi^2=233.91$, $df=84$, $p < 0.001$). Based on the findings, the effects of CMB can be considered non-substantial for this study.

All measures were adapted from validated instruments in prior literature (see Table 1). First, the measures of COVID-19 damage were adapted from several studies on disruptions impacts (Bode et al., 2011; Ambulkar et al., 2015; DuHadway et al., 2019). Second, drawing on prior studies (Chowdhury and Quaddus, 2017; Kern et al., 2012; Wieland and Wallenburg, 2012) BC practices were measured based on four processes: risk identification, risk assessment, risk mitigation and risk control. Third, the concept of disaster readiness is drawn on the works of several scholars (Bode et al., 2011; Ambulkar et al., 2015; Chowdhury and Quaddus, 2017). Fourth, based on several studies in SCM (e.g., Azadegan et al., 2020; Kroes and Gosh, 2010; Wieland and Wallenburg, 2012) financial performance was operationalized as a comparison between respondent company's performance and competition.

We controlled for the size of the firm which was measured using the annual sales (Zouari et al., 2021). Large firms tend to have access to more resources and better control of their BC practices. However, smaller firms may be nimbler in the face of adversity, due to their shorter chains of command (Chowdhury and Quaddus, 2017). We also controlled for the age of the firm given the fact that experienced organizations acquire skills to better deal with SC disruptions and disasters.

5. RESULTS

5.1 Measurement model assessment

Structural Equation Modelling (SEM) was adopted to analyze the data gathered through Amos 23. All constructs are depicted in Table 1.

5.2 Convergent and discriminant validity

The validity of scales was assessed through Cronbach's α reliability scores, T-values and factor loadings (λ) (Table 1). The items factor loading must be greater than 0.5 and significant ($t\text{-value} > 1.96$, $p\text{-value} < 0.05$) to assess the convergent validity of constructs. The items satisfied the requirements. Cronbach's alpha scores are greater than 0.7 which attests to the validity of constructs.

Table 1. Measurement items loadings and reliability

Construct		Loading λ^*	Estimates	S.E	C.R
COVID-19 operational damage ($\alpha = .800$; CR = .842; AVE = .641)					
<i>How did COVID-19 pandemic negatively affect...</i>					
Dam1	Overall efficiency of operations	.885	1.150	.292	3.942
Dam2	Lead time for delivery (delivery reliability)	.741	1.00		
Dam3	Purchasing costs for supply	.768	1.116	.054	3.451
Business continuity practices ($\alpha = .833$; CR = .901; AVE = .694)					
<i>To what extent do these statements apply to your SC?</i>					
BC1	We collect data to be informed about potential supply chain risks and threats	.826	.869	.051	17.139
BC2	We systematically analyze supply chain risk data to identify the possible sources of threats/risks	.837	.970	.055	17.479
BC3	We develop appropriate reaction strategies to mitigate supply chain risks	.842	1.051	.060	17.607
BC4	Over the course of the last three years, we have been able to adopt policies to control supply chain risks' frequency of occurrence	.828	1.000		
<i>To what extent do these statements apply to your SC?</i>					
Disaster readiness ($\alpha = .760$; CR = .889; AVE = .577)					
DR1	We are prepared in terms of systematic disruption detection, detecting disruption quickly.	.589	.685	.072	9.450

DR2	We have readiness training for overcoming crises, i.e., we train employees to be ready for SC disasters	.650	.951	.092	10.370
DR3	We have resources to get ready during crisis.	.662	.919	.087	10.546
DR4	We ensure that there are early warning signals for SC disasters.	.722	1.00		
DR5	We have forecasting to cope with SC disasters and disruptions.	.686	.807	.074	10.886
Financial performance ($\alpha = .881$; CR = .933; AVE = .777)					
<i>Please indicate the level of your company's performance along the following dimensions compared to that of your competitors</i>					
PF1	Profit margin (%)	.900	1.196	.058	20.613
PF2	Return on sales.	.917	1.118	.053	21.229
PF3	Return on total assets.	.874	1.058	.054	19.665
PF4	Sales over assets.	.832	1.00		

*All loadings are significant at $p < .001$; *S.E: standard errors. CR: composite reliability. AVE: average variance extracted.

The discriminant validity of constructs was analysed. The squared correlation of each pair of constructs to average variance extracted (AVE) was compared for each construct. To achieve discriminant validity, squared correlation of two constructs must be less than the variance extracted for each construct, which the results confirm. Confidence intervals (± 2 standard errors) around the estimated correlation between two constructs were calculated. Discriminant validity is achieved if the confidence interval does not include 1.0. The findings confirmed that none of the confidence intervals include 1.0 (not reported). Table 2 includes the descriptive statistics, correlations and AVE of the variables studied.

Table 2. Descriptive statistics, correlations and square root of AVE

Construct	Mean	S.D	COD	BCP	DR	FP
COD	4.24	1.72	.800			
BCP	4.45	1.34	-.119	.833		
DR	4.18	1.55	-.223	.728	.759	
FP	4.11	1.46	.085	.128	-.175	.881

Note(s): Items in bold on the diagonal are the square root of AVE figures, the lower left triangle contains the construct correlations. COD=COVID-19 operational damage, BCP= Business continuity practices, DR= disaster readiness, FP=Financial performance

As an additional test of discriminant validity, we employed the Heterotrait–monotrait (HTMT) analysis approach (Henseler et al., 2016). The discriminant validity can be ensured with a HTMT ratio less than .85 (Henseler et al., 2016). Table 3 indicates that HTMT results demonstrate the adequacy of discriminant validity of all constructs.

Table 3. Discriminant validity results

Construct	HTMT ratio*			
	COD	BCP	DR	FP
COD				
BCP	.263			
DR	.212	.632		
FP	.094	.186	.632	

*Thresholds are 0.85 for strict and 0.900 for liberal discriminant validity. COD=COVID-19 operational damage, BCP: Business continuity practices, DR= disaster readiness, FP=Financial performance

Moreover, we assessed multicollinearity using traditional OLS regression to estimate the variance inflation factors (VIF) for regression coefficients among the independent variables. The results reveal a very low level of multicollinearity as VIF values range from 1.075 to 1.566 which is below the recommended cut-off of 3 for multicollinearity problems.

5.3 Fit indices and hypotheses test

A confirmatory factor analysis was performed to evaluate the goodness-of-fit statistics. The fit indices are beyond the cutoff

values indicating a adequacy of the research model (Table 4). The research model shows satisfactory fit.

Table 4. The model fitness indexes

Fit statistic	Statistics	Threshold range
χ^2/df	2.755	<3.0
p-value	.000	<.05
RMSEA	.0075	<0.08
TLI	.932	>0.9
CFI	.946	>0.91
IFI	.946	>0.9
GFI	.913	>0.9
NFI	.918	>0.81

GFI: Goodness of fit, NFI: Normed fit index, TLI: Tucker Lewis Index, IFI: Incremental fit index, CFI: Comparative fit index, RMSEA: Root mean square error of approximation.

Table 5 summarizes the test of hypotheses and the model.

Table 5. Results of hypotheses tests and model summary

Relationships	B (Estimate)	C.R (t)	p-value	Decision
Controls				
Size → BCP	.110	2.314	.021*	Accepted
Age → BCP	.039	.973	.331	Rejected
Main effects				
COD → BCP	.141	1.297	.194	Rejected
COD → DR	-.370	-2.712	.007**	Accepted
BCP → DR	.983	8.078	.000***	Accepted
BCP → FP	.173	2.080	.038*	Accepted
DR → FP	.243	2.652	.008**	Accepted
Model Summary				
R ²	.401	.051	.031	
ΔR^2	.363	.050	.025	

* $p < .05$, ** $p < .01$, *** $p < .000$. COD=COVID-19 operational damage, BCP= Business continuity practices, DR= disaster readiness, FP=Financial performance. C.R=Critical Ratio.

The coefficient of determination (R^2 or a adjusted R^2) measures the explanatory power of the research model; a value above 0.2 is acceptable (Hair et al., 2019).

6. DISCUSSION

Our results, based on data collected at one point of the COVID-19 disruption (fall 2021), indicate that BC practices have a positive impact on disaster readiness and business performance and that disaster readiness also improves the business performance which corroborates the work of several scholars. The findings indicate the validity of BC practices in the context of COVID-19, which corroborates the tenets of current literature on disruption management. Notwithstanding, there are also aspects that may challenge some of the preexisting knowledge on the topic.

Regarding COVID-19 disruption damage, results show that it deteriorates the firm's disaster readiness and that it does not impact the business continuity practices. This last result comes as a surprise since numerous studies have emphasized the difficulty for many SCs worldwide to continue their activity during the COVID-19 outbreak. Despite being negatively impacted by the COVID-19 damage, disaster readiness can still improve significantly financial performance (Ivanov and Dolgui, 2020). In fact, disaster readiness resulting from firms' processing information from their experience (Chowdhury and Quaddus, 2017) is minimized by the magnitude of the disruptions. Moreover, BC practices have been mostly deployed and maintained since the beginning of the COVID-19 crisis, which might indicate that such practices are likely to have reached some level of maturity. The more experienced firms in terms of BC programs, the more they acquire disaster readiness. Based on such premise, we might surmise that BC practices are not yet at their maximum level of maturity, so that disaster readiness is emphasized at a point where extreme disruptions would not affect this dynamic capability (Norris et

a.l., 2008). Considering that disaster readiness is a concept that underlines the experience and knowledge acquired by firms when they face disruptions, the significant impact of COVID-19 damage on disaster readiness implies that firms had no previous experience of similar disruptions that would have enabled them to design appropriate measures based on a clear understanding of the situation.

Such findings raise several questions regarding the validity of the preexisting knowledge on BC and disaster readiness in the particular context of COVID-19. To recall, numerous studies have previously focused on disruptions related to climatic events and natural disasters such as the Fukushima Tsunami in Japan in 2011. However, such disruptive events have smaller repercussions than those of the COVID-19, with the latter coupled with an entanglement of international exchanges that have become much denser in the last decade. In this perspective, relying on widespread BC practices does not seem sufficient for a firm to guarantee its financial performance in the volatile context of COVID-19. Indeed, disaster readiness, as a set of SC resources and dynamic capabilities, has proven its contribution to financial performance but is now negatively impacted by the magnitude of the COVID-19 damages. Firms need to quickly process the information collected since the beginning of the crisis to learn, draw lessons, and thus optimize their disaster readiness.

7. CONCLUSION

The results show the significant and negative impact of the COVID-19 crisis on disaster readiness but not on BC practices. Insofar as disaster readiness is a dynamic capability (Norris et al., 2008) and BC practices are rooted in OIP theory (Azadegan et al., 2020), the following insights are gained: (1) the findings illustrate the difficulty of mobilizing dynamic capabilities and making them truly operational when they are needed; and (2) the results emphasize that information processing remains one of the fundamental activities of the SCM that companies can rely on in times of crisis. Overall, while this study shows that the combination of these two theoretical perspectives works well and provides corroboration of the basic tenets of OIP theory, it also highlights the known limitations of RBV/DCV.

From this study, SC managers can understand that the development of BC practices, based on better information management, leads to a better financial performance of the company during a crisis. Moreover, disaster readiness, as a dynamic capability, is also a driver of financial performance. However, this dynamic capability does not seem to be sufficiently developed since the COVID-19 crisis has deteriorated it (which is not the case for BC practices). This result is relevant for companies that should quickly implement organizational learning processes, for example in the form of feedback that is recorded in a knowledge management system, to ensure that disaster readiness is improved for the next crisis.

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