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RESPONDING TO SHOCK EVENTS TIME TO RECOVERY, INDICATORS, AND STRATEGIC APPROACHES

By analyzing a sample of 525 Italian companies, the study examines their level of resilience during the first wave of COVID-19. Our main objectives are twofold. On the one hand, we want to determine how the level of business resilience, as measured by specific indicators, can contribute to reducing the time-to-recovery (TTR). This will provide insights into the relationship between the recovery time of business flows and the stability of business performance during a disruption. On the other hand, from the perspective of managerial decision-making, we aim to identify practices that can improve the level of resilience of business operations.

SUPPLY CHAIN//OPERATIONS MANAGEMENT//RESILIENCE STRATEGIES//SUSTAINABILITY//TIME-TO-RECOVERY



DANIEL RUZZA

is a postdoctoral researcher in the PNNR Management Project - GRINS at Bocconi University (Milan, Italy).

CRED (Centre for Research on the Epidemiology of Disasters) is a research unit at the University of Leuven that has been studying international disasters and conflicts for more than 30 years, integrating research and training activities with relief, rehabilitation and development activities. Since 1988, CRED has been monitoring events and disasters by collecting and analyzing information published in the Emergency Events Dataset (EM-DAT). The frequency of disasters year after year has multiplied. In fact, from an average of 200 disasters per year in the 1980s, the number rose to over 300 by 2010, and today more than 56% of companies worldwide face at least one unforeseen situation each year. These disruptive events range from natural disasters like tsunamis and

earthquakes, to pandemics, including the recent COVID-19 crisis, to man-made disasters, such as geopolitical tensions, conflicts, terrorist attacks, and economic crises.

Much of the literature on disruption management argues that the most effective strategy in the current environment is to minimize the risk of such events occurring, or at least to reduce the likelihood that they will affect the company's core business (Macdonald and Corsi, 2013). However, there are events of such magnitude that they have an intense, unpredictable impact on the entire value chain, regardless of the accuracy and effectiveness of risk planning systems. When such events cannot be predicted, a company can only attempt to mitigate their impact and recover in the aftermath as quickly as possible.

Therefore, in addition to preventive activities pertaining to risk planning and management, we need to understand how to effectively implement the phases of response and recovery from discontinuities (Ali et al., 2017). Resilience, or the ability to maintain or even improve performance indicators during periods of turbulence, plays a central role in this context. The most serious and dangerous effects of a disruption manifest in the loss of performance, which threatens the competitiveness of a company. In this case, the concept of performance is not limited to the financial sphere, which generally garners more attention, but also includes other indicators that can signal the impact of a discontinuity before it's reflected in the financial statements. These indicators are grouped into the three categories below.

- **Operational performance:** monitoring product quality, inventory management, and on-time delivery.
- **Go-to-market performance:** tracking sales, customer service, and market share.
- **Performance related to invested resources:** including indicators such as ROI (Garrido-Moreno et al., 2024; Gu et al., 2021).

Following a disruption, the primary goal of any company is to minimize the impact by restoring business operations as quickly as possible – a critical factor in ensuring business continuity and containing the costs associated with the disruptive event.

Longer recovery times result in higher costs and reduce the likelihood of full recovery. This concept is measured by Time To Recovery (TTR), which captures how long it takes for an organization to return to full pre-crisis operations. Clearly, the speed and success of the recovery depends largely on the skills and decisions of managers.

To illustrate the importance of managerial decisions on TTR, the case of Nokia and Ericsson offers useful insight (Sheffi, 2005).

In 2000, Philips was the main supplier of chips for mobile phones when a fire in the Albuquerque plant destroyed part of the production facilities and most of the inventory.

Nokia reacted quickly and proactively, finding new suppliers within days and managing to keep its performance virtually unchanged. Ericsson, on the other hand, took a wait-and-see approach to crisis management, allowing several weeks to pass before taking any concrete action. This delay proved costly: Ericsson lost significant market share to Nokia, suffering an economic blow estimated at \$2.3 billion.

In today's socio-economic context, characterized by frequent crises and strong competitive tensions in many industries, companies can't stall in the face of disruptive events: interventions must be timely and targeted. To identify the performance indicators that businesses need to monitor to detect early signs of impact, intervene promptly and minimize TTR, we examined a sample of 525 Italian companies exposed to the first wave of COVID-19. For each company, we compiled and analyzed the above indicators and assessed their correlation with post-pandemic TTR.

RESILIENCE AND PERFORMANCE INDICATORS

The discontinuity management literature distinguishes two main ways in which discontinuities can affect companies: through financial and economic impacts and through impacts on service delivery (Yu and Qi, 2004). The former refers to the costs and lost revenues resulting from a disruptive event, while the latter encompasses all disruptions that impede the conduct of normal business activities and ultimately prevent the firm from meeting customer demand. The impact on service delivery can be measured using performance indicators divided into the categories mentioned above: operational performance, go-to-market performance, and investment-related performance.

Operational performance summarizes the performance indicators of business operations related to production and logistics processes (De Leeuw and Van Den Berg, 2011). In this category, three indicators were considered that monitor inventory management, quality of finished products, and timeliness of deliveries.

Inventory management concerns a company's ability to keep enough goods or products on hand to meet the demands of internal and external customers. A disruption can upset the delicate balance between purchasing, production and sales, negatively impacting inventory management. For example, during the COVID-19 pandemic, transportation restrictions, factory closures, and supply difficulties caused supply chain disruptions for 75% of companies worldwide (Tanaka and Guo, 2020). In addition, changes in customer consumption habits can lead to fluctuations in demand, accelerating the obsolescence of some products and further complicating inventory management due to the risk of accumulating unsold inventory.

The second operational performance indicator considered here is product quality, which measures a company's ability to maintain high

operational standards even under disruptive conditions. The quality of a product refers to its features, functionality and performance, and must meet or exceed customer expectations and desires.

Quality encompasses various aspects, including durability, reliability, functionality, safety, and aesthetics. During a disruption, product quality can be compromised by disruptions in the supply chain, resulting in shortages of raw materials and subsequent downtime and the need for rescheduling. Similarly, restrictions and safety measures imposed during disruptive events, such as pandemics, may result in a shrinking workforce or changes in working conditions. Shortages of skilled personnel and changes in production arrangements can adversely affect product quality, especially if they interfere with training and supervision activities and quality control measures. However, since high product quality is one of the key differentiators from competitors (Clemons and Slotnick, 2016), disruptions can also represent an opportunity. Indeed, companies can use the crisis to assess and bridge the quality gap with the competition to strengthen their position in the market.

The third operational performance indicator is delivery capability, which measures reliability and efficiency in fulfilling customer orders. This factor is particularly important because it reflects the efficiency of the supply chain. In fact, to meet lead times, companies must coordinate and synchronize various processes effectively, including order processing, inventory management, production, and logistics planning and execution. Satisfactory lead times are contingent on a smoothly functioning supply chain that minimizes disruptions and optimizes resource utilization. Disruptions affect the entire supply system and require additional effort from companies to maintain this delivery capability at a level consistent with competitive demands, avoiding delays, capacity constraints, and order fulfillment limitations.

Go-to-market performance measures the ability to introduce and maintain products and services in the marketplace. Three main indicators were considered in this category: sales, pre- and post-sales customer service, and market share. During a disruption, sales play a key role because the most critical economic and financial impact comes from the company's inability to generate revenue. This can be caused by product unavailability, store closures, shortages of goods on shelves or in warehouses, or lack of alternative options. Ensuring sales continuity is essential to maintaining sufficient cash flow to cover costs, invest in growth opportunities, increase resilience, and facilitate rapid recovery. By carefully monitoring of sales, companies can assess their financial performance, detect the impact of a disruption on their financial and economic equilibrium and gauge its severity in a timely fashion. In addition, sales provide valuable insights for adapting marketing strategies to changing socio-economic conditions, allowing production and distribution to be adjusted accordingly.

The second go-to-market indicator is customer service, which refers to the support and assistance provided to the customer before, during, and after the purchase. This service is critical to building and maintaining customer satisfaction, loyalty, and trust by responding to customer inquiries, resolving problems or complaints, and ensuring an overall positive shopping experience. During a disruption, customer service plays a key role in clearly and effectively communicating the difficulties and issues caused by the disruption. Studies show that product unavailability, delivery delays, and any quality discrepancies are more readily accepted by customers in the presence of effective customer service (Gorry and Westbrook, 2011). In addition, quality customer service contributes to customer loyalty, which translates into a stable customer base and repeat sales. During periods of uncertainty, when traditional demand forecasting models may be less effective, information from customer service can help improve the accuracy of estimates, which in turn optimizes inventory management and production planning.



The third go-to-market indicator is market share, which measures a company's presence and competitiveness relative to its competitors. Traditional strategies to boost market share, such as expanding product lines and moving into heterogeneous markets (Tang, 2006), can be counterproductive in a crisis because they tend to proliferate production complexity and associated costs. In addition, changes in buying habits, contractions in some sectors, difficulties in reaching consumers, and problems in the supply chain increase the risk associated with these strategies. This can affect a company's profitability and financial stability, reducing the resources available for future growth and investment.

Investment performance, reflecting a company's ability to manage its investments wisely, is measured by ROI. Disruptions tend to have a negative effect on ROI because of their impact on revenue and the additional costs of implementing security measures to maintain business continuity or adapt operations to changing circumstances.

During disruptions, uncertainty and financial challenges intensify, forcing companies to prioritize resource allocation to projects or initiatives that can contribute to satisfactory ROI. In this context, thanks to ROI, in its aggregate form, companies can assess the effectiveness of their investment activities and their ability to adapt to changing market conditions. This in turn enables informed investment allocation decisions and secures the effective and efficient use of resources. By analyzing the components of ROI, companies can also evaluate the dynamics related to prices, costs, volumes, and efficiency of fixed and current assets. The purpose of this is to identify areas for improvement and opportunities for intervention. ROI also serves as a benchmarking tool, useful for comparing the profitability of investments over different time periods or among similar enterprises.

PERFORMANCE INDICATORS AND TIME TO RECOVERY

To identify what activities management should focus on to improve TTR, in the sample we analyzed the correlation between TTR and the performance indicators related to each of the categories described above. Note that the correlation does not imply a direct cause-and-effect relationship; instead it should be interpreted as the tendency for the TTR to change if there is consistently high performance in one of the areas described.

Table 1 illustrates our results. As might be expected, all the performance indicators show a positive correlation with better TTR, suggesting that improvement in each indicator contributes to a faster recovery in business performance. Although this may seem obvious, some indicators have a higher absolute value than others, suggesting a more intense effect. As shown in Table 1, the indicator associated with sales activities is the most influential, while the delivery indicator is the least influential.

Looking at the individual indicators, we can see that effective inventory management during a disruption promotes the rapid recovery of pre-crisis operations, ensuring the immediate availability of raw materials and components needed to resume normal business activities. Conversely, suboptimal inventory management can cause delays due to the need to restore normal levels of raw materials. Some functional strategies for proper inventory management include supplier diversification, which reduces the risk of supply chain disruptions, and keeping buffer stocks, which protects against unexpected spikes in demand or delays in supply.

Similarly, a high-performing customer service is critical to maintaining a strong customer base during a crisis. Brand loyalty is a key competitive advantage in the post-disruption recovery phase, guaranteeing customer retention at a time when new customer acquisition may be more

difficult. In this sense, training customer service personnel and using technology to improve service can enhance the effectiveness of customer interactions, securing a stable customer base and faster recovery.

Maintaining sales continuity during periods of uncertainty is a clear indicator of a company's presence and stability in its markets. The ability to absorb consistent sales volumes provides a competitive advantage during recovery by reducing the time associated with the marketing and communications activities required to bring products and services back to market. In addition, sales continuity provides regular cash flows, ensuring financial stability and resources to invest in recovery.

A higher ROI indicates an efficient use of invested resources. As we've seen with sales, one way to strengthen a company financially in the face of disruptions is to build an investment portfolio that is resilient to discontinuities (and as such able to limit losses or generate gains even during downturns). This strength facilitates and accelerates recovery by providing more financial resources than competitors.

Product quality is directly linked to brand image and the reliability of the production logistics system. By maintaining consistent product quality, companies signal to customers that product standards remain unchanged even during disruptive events. As a result, quality helps maintain the company's reputation with its customers by increasing the likelihood that they will make repeat purchases during the recovery.

Finally, market share reflects a firm's competitive position. Companies with larger market shares enjoy a stronger position in their target markets and can exercise greater bargaining power with their customers and suppliers, facilitating a faster recovery.

RESILIENCE STRATEGIES

From a management perspective, it's vital to identify practices that increase the level of resilience, measured, as above, by monitoring TTR-related performance indicators (Table 2). Resilience is an indispensable strategic capability that enables rapid anticipation, adaptation, response, and recovery following an unexpected impactful event. To design an effective crisis management system and support resilience, companies would do well to examine discontinuities at three key moments: before, during, and after the disruptive event. At each of these stages, performance indicators tracking provides early warning of the need for specific strategic actions to minimize TTR and facilitate rapid recovery.

Each discontinuity phase involves different strategic actions, which can be classified as follows:

- Proactive actions to prepare for a disruptive event.
- Contingency actions to respond to the disruption.

TABLE 1. CORRELATION BETWEEN RESILIENCE AND PERFORMANCE INDICATORS OF SPECIFIC AREAS. ALL VALUES ARE SIGNIFICANT

	Stock availability	Delivery	Product Quality	Sales	Customer Service	Market share	ROI
Time to Recovery	-0.147**	-0.089*	-0.105*	-0.329***	-0.221**	-0.150**	-0.199**

***p-value<0.01; **p-value<0.05; *p-value<0.1.

- Reactive actions to restore performance after the unexpected event has occurred.

Effectively managing these strategic actions requires specific capabilities and underlying enablers. For example, preparing for proactive actions depends on the ability to anticipate and identify the possibility of a disruptive event occurring. This requires effective monitoring of environmental changes and changes in indicators before business performance is impacted. Once a potential threat is identified, the implementation of competing actions depends on adaptive and responsive capabilities. The former involve the continuous adjustment of business activities to ensure the availability of critical resources during disruptions, while the latter enable an effective and timely response to events.

Finally, preparing for responsive actions in the post-discontinuity phase calls for resilience and learning capabilities. Thanks to resilience, the company can readjust and return to normalcy after the upheavals caused by the discontinuity. Learning skills are useful for analyzing the events that have occurred, assessing their impact, evaluating the effectiveness of the countermeasures taken. All this serves to improve the prevention and response system in a cyclical review perspective.

Expanding on the approach we propose, each of the capabilities described above is in turn made up of specific enablers that facilitate their development.

- Anticipatory capability requires awareness of potential emergencies through a thorough understanding of the company's vulnerabilities, robustness to change, discontinuities and the possibility of their occurrence, corporate safety and soundness in the face of possible crises, and data management (pre-disruption).
- Adaptive and responsive capabilities require flexibility in adapting to change, redundancy through maintaining excess capacity,

collaboration with supply chain partners, and agility and speed in responding to discontinuities.

- Recovery and learning capabilities include contingency planning or reviewing existing plans, assessing the market position potentially changed by the crisis, and managing the knowledge and lessons learned from the discontinuity. Social capital and relationships with other members of the value chain should be leveraged to promote learning and strengthen connections.

The performance indicators detailed in this article are necessary to monitor each of the capabilities we have described. To respond to a crisis in a timely manner, companies need to pay attention to the dynamics of each indicator in all phases of discontinuity, since there is no single category that takes priority over the others. Given their correlation with the TTR, indicators that are kept under control and that display no excessive discontinuities suggest the possibility of restoring an adequate level of operations in a short time. Table 2 summarizes specific practices that can be followed to develop the key capabilities we describe and to realign performance indicators with business objectives.

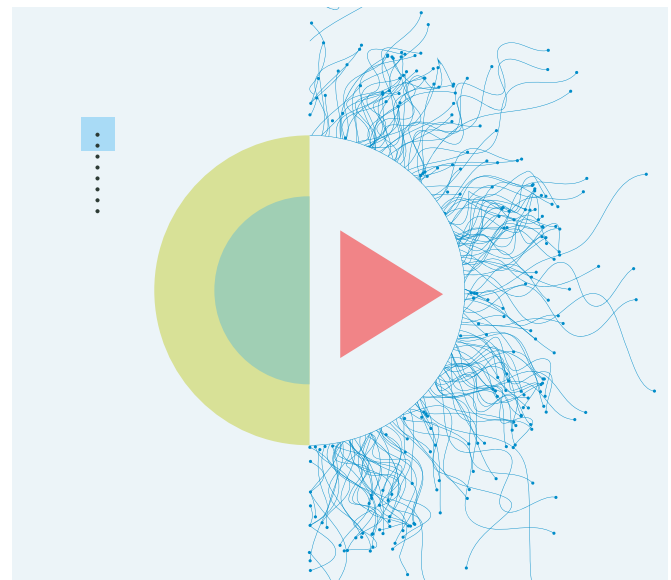


TABLE 2. RESILIENCE PRACTICES IN THE STAGES OF DISCONTINUITY (ADAPTED FROM ALI ET AL., 2017)

Discontinuity phase and consequent actions	Key capabilities	Enabling elements	Praxis
Antecedent phase and proactive strategic actions	Ability to anticipate	Awareness of the situation	• Monitoring and interpretation of events, • Continuity planning, • Mapping supply chain vulnerabilities, • Preparation of warning strategies, • Risk prevention and containment, • Risk control/transfer/sharing with supply chain partners.
		Robustness	• Supply chain network design favoring: segmentation, decentralization, density. • Identification of critical partners, • Design management and product flow, • Preparation of a delivery strategy, • Anticipation/preparation for change.
		Visibility	• Performance monitoring through KPIs, • Predisposition of an IT capability, • Information sharing with partners, • Implementation of integrated systems for transparency, • Fostering connections.
		Security	• Ensure physical/commodity security, • Introduce a culture of safety, • Prepare countermeasures to counterfeiting, • Cybersecurity, • Introduce multi-level defense systems, • Creating public-private partnerships (PPPs), • Fostering cooperative strategies with supply chain partners
		Knowledge management (pre-interruption)	• Know your supply chain deeply, • Education and training, drills, simulations, and supply chain exercises, • Introducing the culture of resilience, • Involve board leadership, • Create a risk management department, • Fostering risk awareness, • Fostering inter-organizational learning.
Concurrent phase and competing strategic actions	Adaptability	Flexibility	• Flexible supply through multiple suppliers, • Flexible production processes or resources, • Flexible product via referral, • Flexible pricing through responsive pricing, • Flexible transport mode, • Flexible order fulfillment
		Redundancy	• Maintain overcapacity in production, transportation, or resources, • Rely on multiple suppliers, • Store safety supplies, • Prepare a strategic inventory, • Provide backup/emergency storage facilities, • Maintain low capacity utilization.
	Responsiveness	Collaboration	• Plan collaboratively with supply chain partners, • Sharing information with partners, • Coordinating with partners, • Cooperate with competitors as well.
		Agility	• Speed in adapting to change, • Responsiveness to respond to unexpected situations.

Discontinuity phase and consequent actions	Key capabilities	Enabling elements	Praxis
Next phase and strategic reactive actions	Recovery capacity	Emergency planning	• Reconfiguring the supply chain, • Acquire the necessary resources to cope with future crises, • Prepare restoration plans, • Reduce time to market, • Prepare scenario analyses.
		Market position	• Increase financial strength (consider mergers and acquisitions), • Increase market share, • Maximizing efficiency, • Improve adaptability to unexpected situations, • Structuring customer relationships, • Increase communications with customers.
	Learning ability	Knowledge management (post-interruption)	• Investing in education and training, • Collect post-interruption feedback, • Increase knowledge of the costs/benefits of actions taken to cope with the crisis, • Becoming a continuous learning organization, • Looking beyond the risks to see the opportunities, • Increase innovation in emergency planning and continuity management
		Social capital	• Improve trust with internal collaborators and external partners, • Fostering inter-organizational relationships, • Improving interpersonal competence, • Leveraging co-creation processes



REFERENCES

Ali, A., Mahfouz, A., Arisha, A. (2017). "Analysing supply chain resilience: integrating the constructs in a concept mapping framework via a systematic literature review", *Supply Chain Management*, Vol. 22 No. 1, pp. 16–39.

Clemons, R., Slotnick, S.A. (2016). "The effect of supply-chain disruption, quality and knowledge transfer on firm strategy", *International Journal of Production Economics*, Elsevier, Vol. 178, pp. 169–186.

Garrido-Moreno, A., Martín-Rojas, R., García-Morales, V.J. (2024). "The key role of innovation and organizational resilience in improving business performance: A mixed-methods approach", *International Journal of Information Management*, Elsevier Ltd, Vol. 77 No. March, p. 102777.

Gorry, G.A., Westbrook, R.A. (2011). "Once more, with feeling:

Empathy and technology in customer care", *Business Horizons*, Vol. 54 No. 2, pp. 125–134.

Gu, M., Yang, L., Huo, B. (2021). "The impact of information technology usage on supply chain resilience and performance: An ambidexterous view", *International Journal of Production Economics*, Elsevier B.V., Vol. 232 No. December 2019, p. 107956.

De Leeuw, S., Van Den Berg, J.P. (2011). "Improving operational performance by influencing shopfloor behavior via performance management practices", *Journal of Operations Management*, Elsevier B.V., Vol. 29 No. 3, pp. 224–235.

Macdonald, J.R., Corsi, T.M. (2013). "Supply chain disruption management: Severe events, recovery, and performance", *Journal of Business Logistics*, Vol. 34 No. 4, pp. 270–288.

Sheffi, Y. (2005), *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*, MIT Press, Cambridge, MA.

Tanaka, T., Guo, J. (2020). "How does the self-sufficiency rate affect international price volatility transmissions in the wheat sector? Evidence from wheat-exporting countries", *Humanities and Social Sciences Communications*, Springer US, Vol. 7 No. 1, pp. 1–13.

Tang, C.S. (2006). "Perspectives in supply chain risk management", *International Journal of Production Economics*, Vol. 103 No. 2, pp. 451–488.

Yu, G., Qi, X. (2004). *Disruption Management: Framework, Models and Applications*, World Scientific Publishing Company, Singapore.



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