

Identification and analysis of Disruptions: the first step to understand and measure Enterprise Resilience

Raquel Sanchis¹, Raúl Poler¹, Francisco Cruz Lario¹

Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP).
Universitat Politècnica de València. Plaza Ferrándiz y Carbonell, 2. 03801
Alcoy – Alicante – España. rsanchis@cigip.upv.es, rpoler@cigip.upv.es,
fclarior@cigip.upv.es

Abstract Currently, organizations are increasing their awareness about the need to be prepared and ready to face up to disruptions. Enterprises should be agile, flexible, dynamic and proactive, to react to any disruption in order to change, adapt and/or recover quickly. This paper reviews the enterprise resilience concept and shows the main characteristics of disruptions, in order to identify the foundations of the aspects that impacts on the capacity of resilience of the enterprises. The paper also shows some techniques as initial attempts to analyse the level of enterprise vulnerability and proposes a combination of these two methods to define the first stage of a methodological framework to asses enterprise resilience.

Keywords: Disruptions, Enterprise Resilience, Vulnerability, Adaptative Capacity, Recovery Ability

1.1 Introduction

Currently, products' life-cycles are very short, the business environment is increasingly unstable, the competitiveness in markets has a more global perspective, customers have more power in the negotiation processes and organizations are increasingly exposed to potential disruptions. So far, the way in which the organiza-

¹ R. Sanchis (✉)

Centro de Investigación en Gestión e Ingeniería de Producción (CIGIP). Universidad Politècnica de Valencia. Plaza Ferrándiz y Carbonell, 2. 03801 Alcoy – Alicante. Spain.
e-mail: rsanchis@cigip.upv.es

tions managed their businesses does not guarantee a rapid, effective and efficient response to unexpected situations which could have a negative effect. Therefore, enterprises should be agile, flexible, dynamic and proactive, to quickly react to whatever critic eventuality in order to change, adapt and/or recover as soon as possible by aligning its strategy, processes, technology and personnel to achieve their goals, maximizing their performance and ensuring their ability to respond to the current ongoing and increasingly severe changes. This ability has been defined as Enterprise Resilience (ER).

Dalziell and McManus (2004) suggest that resilience was firstly proposed in the field of ecology (Holling, 1973) and the author classified it as: (i) a system (ecosystem, society or organization) that persists in a state of equilibrium (stability) and (ii) how these dynamic systems behave when they are stressed and moved from this balance. Dalziell and McManus (2004) apply the term of resilience to the business world, and they describe that the overall goal of a system is to continue working as much as possible to face up to a disruptive situation in order to achieve its purpose. In this case, resilience was considered as a function of both: system vulnerability and adaptive capacity. When a disruption takes place, an organization is driven from a state of relative equilibrium to another state characterized by instability. The ease with which the organization is moved to this new unstable state is a measure of the vulnerability, while the degree with which the organization faces up to this change, is a measure of its adaptive capacity.

Erol et al. (2010) define ER as an enterprise's capability to decrease the level of its vulnerability to expected and unexpected threats, its ability to change itself and adapt to its changing environment, and its ability to recover as soon as possible.

McManus (2007) states that ER is a function of an organisation's: (i) situation awareness, (ii) management of keystone vulnerabilities and (iii) adaptive capacity in a complex, dynamic and interconnected environment.

1.2 Literature Review: Disruptions

In order to understand why some enterprises are more resilient than other, this section makes a literature review of disruptions, as first step to understand and measure the ER. Barroso et al. (2011) state that disturbances may cause disruptions in flows of information, materials and/or finance in one or more supply chain entities. These disruptions may have a negative influence on an enterprise's normal operations, thus making it vulnerable and reducing its performance and competitiveness. Therefore, it is essential for the survival and the effective and efficient running of any enterprise, to identify, in a proactive manner, the disruptions that may potentially affect the companies by analyzing and measuring their ER to develop mitigation policies and/or contingency plans to minimize the vulnerability.

There is no consensus in the literature regarding the term used for disruption. Some authors use the term "disturbance" (Svensson, 2000, Kleindorfer and Saad, 2005, Barroso et al., 2011) others prefer to use "risk" (Chopra and Sodhi, 2004, Goh et al., 2007), "uncertainty" (Mason-Jones & Towill, 1998) and even "crisis" (Natarajarathinam et al., 2009). In this paper, the term used is disruption or its synonymous: disruptive event.

Svensson (2000) and Kleindorfer and Saad (2005) define a disturbance, which in this paper is named disruption, as an unplanned and unexpected disturbance that disrupts the normal flow of products and materials in an enterprise or supply chain. Barroso et al. (2011) defines it as foreseeable or unforeseeable perturbation that affects the normal functioning and stability of an organization or supply chain. The only difference between the previous definitions is the predictability of the disruption since the first authors consider that the disruptions cannot be predicted while Barroso et al. (2011) in their definition consider disruptions as foreseeable events.

Sheffi and Rice (2005) explain that any significant disruptive event has an impact on business performance, whether measured in sales, production level, benefits, customer service or other relevant metrics, and divide a disruptive event into 8 different phases: 1. Preparation: In some cases, companies can anticipate and prepare for a disruptive event in order to minimize its effects; 2. Disruptive event: Any situation that threatens the daily operation of a company, such as strikes, government bans, etc; 3. First response: The company reacts and takes the first and appropriate decisions in order not to aggravate the situation; 4. Initial impact: The impact of some disruptive situations occurs immediately while other disruptive events affect the company in the long term; 5. Time of full impact: Whether immediate or long term, once the disruptive event fully impacts on the company, the performance decreases significantly; 6. Preparation for recovery: This phase usually start in parallel with the first response and sometimes even before the disruptive event, if it has been foreseen; 7. Recovery: To return to the previous production levels, many companies compensate their loss of production, increasing their normal production capacity, using overtime and customer and supplier resources; 8. Long-term impact: After a disruptive situation, companies need time to recover depending on the severity of the consequences.

As aforementioned, there was no unanimity in literature in the use of the term of disruption, since concepts such as crisis, disturbance, uncertainty, etc ... are used in a synonymous way. Similarly, the analysis of the literature has revealed no consensus among authors with regard to the concept of disruptions and their causes. Both terms are sometimes used with the same meaning, what can cause confusion. For example, a fire at an industrial plant (in which the production system is really damaged) that has to serve an order of components to an assembler, is a disruption for the assembler, because it has to stop its production since the components do not arrive on time. While from the industrial plant point of view, the fire is cause and disruption at the same time.

The classification and distinction of the causes and disruptions is a complicated task as in many cases the two concepts are confused. Barroso et al. (2011) presents a classification framework of both concepts. They consider that the disruption of a company or supply chain could be caused due to internal or external causes. The own resources of an organization, would be internal sources of a disruption, while external sources would include customers, suppliers, nature and men's actions (by accident or intentionally). They explain that these external sources are independent of a specific organization and in most cases are unpredictable.

Table 1.1 Classification of disruption taking into account their causes (Barroso et al., 2011).

Disruptions	Causes	Internal				External			
		Human	Equipment	Energetic	Financial	Supply	Man made	Nature	Customer
Machine breakdown		✓	✓	✓	✓		✓	✓	
Infrastructure problem							✓	✓	
Scarse Human		✓			✓		✓	✓	
Supply failure		✓	✓	✓	✓	✓	✓	✓	
Sudden change in demand									✓
...									

According to the report of Ernst & Young Business Risk (2010), enterprises conceive as the most important disruptions, those related to aspects such as uncertainty about new legislation, the rising levels of government debt that could have a strong impact on the cost of credit. . Companies are also worry about the current financial crisis, because there is no guarantee that global growth will be sustained if stimulus packages are withdrawn. Other causes for concern are human capital management, emerging markets with emerging economies likely to dominate global growth, commodity price inflation and pressure from low cost competitors, changes in consumer preferences due to environmentally friendly products as well as new environmental legislation, the image, social acceptability and the corporate social responsibility as any threat to the reputation of a company can be fatal.

1.3 Measurement of the Enterprise Resilience through the Disruptions

The current turbulent and changing environment continually causes disruptions that could have strong and negative effects in enterprises. For this reason, companies should be resilient enough to anticipate the effects of disruptions and improve the capacity of ER and recovery. Sanchis and Poler (2010) propose a methodological framework to assess ER that is aligned with the disruption's phases proposed by Sheffi and Rice (2005). Fig 1.1 shows the different stages to evaluate

ER. The phases of this framework cover the definition of metrics in order to measure ER and depending on the results obtained, the next objectives would be: (i) to develop immediate actions to improve ER; (ii) define strategies and action protocols and, (iii) to search solutions to face up to the possibility that the company is affected by a disruptive event.

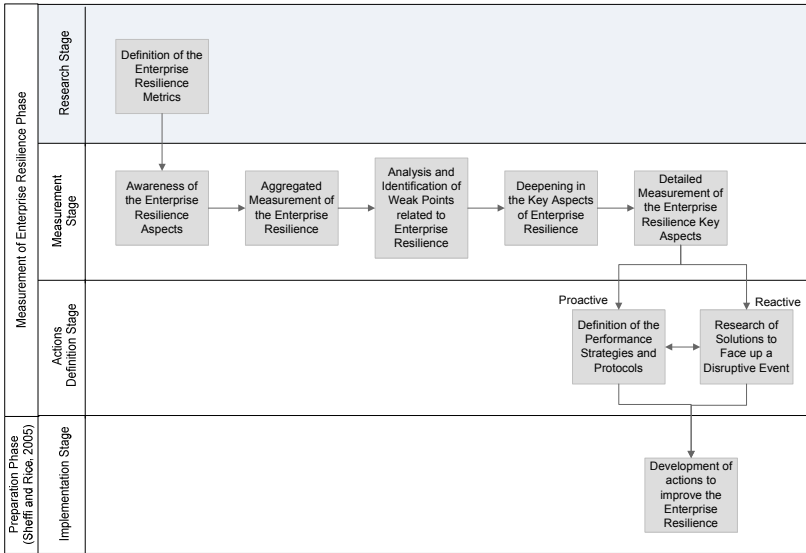


Fig. 1.1 Methodological framework to assess ER (Sanchis and Poler, 2010).

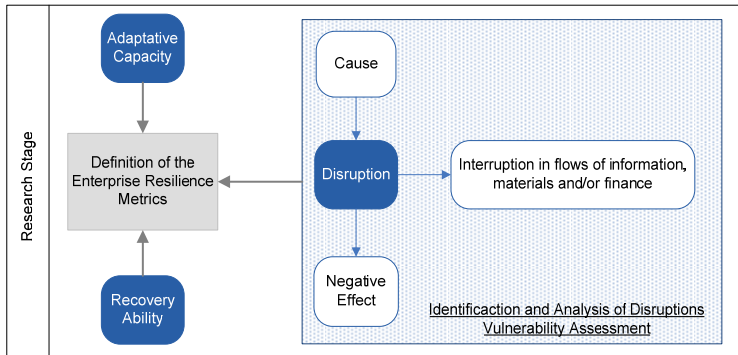


Fig. 1.2 Identification and Analysis of Disruptions, the first step to assess ER.

As aforementioned, the first stage consists of defining ER metrics to measure the capability of reaction and recovery to face up to disruptions. However, prior to this stage, it is necessary to identify and analyze the potential disruptions. Therefore, the detailed description of such a stage is shown in Fig. 1.2. The study of the

adaptative capacity as well as the recovery ability fall outside the scope of this paper.

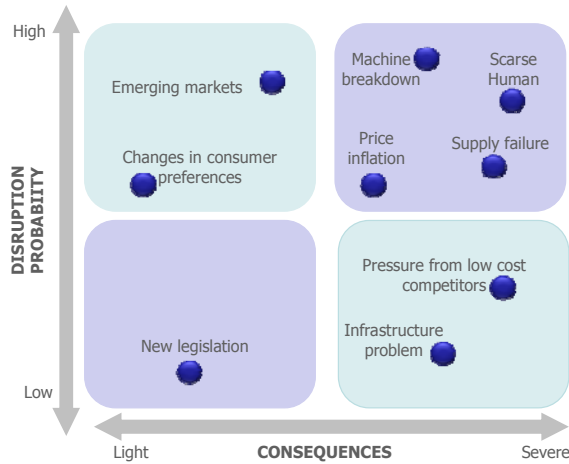


Fig. 1.3 Example of a vulnerability map (adapted from Sheffi and Rice, 2005)

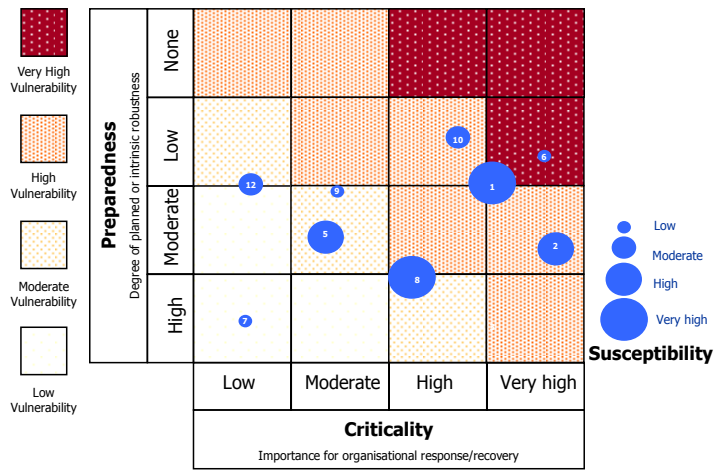


Fig. 1.4 Example of a vulnerability matrix (McManus, 2007).

The literature offers some attempts to identify and analyze disruptions. Sheffi and Rice (2005) propose vulnerability maps to identify and analyse disruptions. Fig. 1.3 shows an example of a vulnerability map that categorizes the relative likelihood of potential threats to an organization and the significance degree of disruptions effects. McManus (2007) extends the vulnerability maps and propose vulnerability matrixes (Fig. 1.4). These matrixes encompass aspects of the preparedness and criticality of an enterprise to face up to disruptions. In addition,

the matrixes also take into account the susceptibility, which is the degree of tolerance of the organization to face up to such a disruption.

Sheffi and Rice (2005) vulnerability maps do not take into account the preparedness capacity of an organization, i.e., its readiness degree to face up to disruptions. While McManus (2007) vulnerability matrixes consider this aspect, but the probability of occurrence of disruptions is not analyzed. For this reason, this paper proposes a combination of both previous proposals (Fig.1.5), because it is essential to analyze the main vulnerabilities of an organization considering the following aspects: (i) the status of readiness of an enterprise when a disruption impact on it, (ii) the probability of occurrence of such a disruption and (iii) the negative effects or consequences that the disruption causes on the enterprise. In order to focus on the most “dangerous” vulnerabilities, Fig1.5 shows in red, those ones that are dangerous; in yellow, the ones that need to be controlled and the green ones are the less problematic.

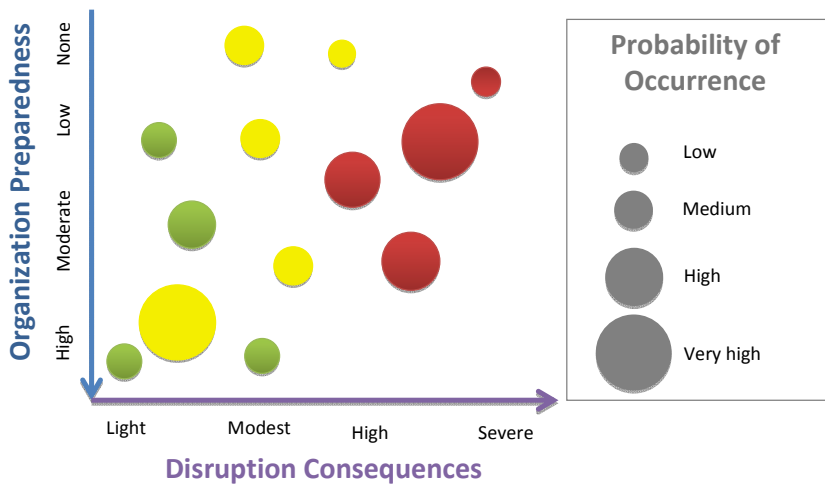


Fig. 1.5 Example of a vulnerability diagram.

Moreover, the criticality feature is also studied in McManus (2007) matrixes, however although this concept has relationship with vulnerability paradigm, is more related to adaptative capacity analysis field.

1.4 Conclusions and Further Research

It is important that enterprises know their capacity to decrease the level of vulnerability when they face up to disruptions in order to adapt (adaptative capacity) to the current changing environment and to recover (recovery ability) as soon as

possible when a disruption impacts on an enterprise. The identification and analysis of the disruptions is the first step in order to define metrics to assess the ER. The literature shows some techniques to perform this task, however this paper proposes a combination of both methods to characterize the potential disruptions that can affect an enterprise, through vulnerability assessment, with the objective to study the ability to overcome such disruptions, and develop the overall methodological framework to assess the ER from all its perspectives.

1.5 Acknowledgement

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° NMP2-SL-2009- 229333.

1.6 References

- Barroso AP, Machado VH, Cruz Machado, V (2011). Supply Chain Resilience Using the Mapping Approach. In: Supply Chain Management. InTech.
- Chopra S, Sodhi MS (2004). Managing Risk to Avoid Supply-Chain Breakdown. *Sloan Manage Rev* 46(1): 53–61
- Dalziell EP, McManus ST (2004). Resilience, Vulnerability, Adaptive Capacity: Implications for System Performance. Proceedings of the International Forum for Engineering Decision Making (IFED), Stoos.
- Ernst & Young Business Risk Report (2010). The top 10 risks for global business. A sector-wide view of the risks facing businesses across the globe.
- Erol O, Henry D, Sauser B, Mansouri M (2010). Perspectives on Measuring Enterprise Resilience. Proceedings of 4th Annual IEEE International Systems Conference, San Diego.
- Goh M, Lim JYS, Meng F (2007). A stochastic model for risk management in global supply chain networks. *Eur J Oper Res* 182: 164–173
- Holling CS (1973) Resilience and stability of ecological systems. *Annu Rev Ecol Syst* 4:1–23
- Kleindorfer P, Saad G (2005). Managing disruption risks in supply chains. *Prod Oper Manag* 14(1): 53–68
- Natarajarathinam M, Capar I, Narayanan A (2009). Managing supply chains in times of crisis: a review of literature and insights. *Int J Phys Distr & Logs Manage* 39(7): 535–573
- Mason-Jones R, Towill D (1998). Shrinking the supply chain uncertainty circle. *IOM Contl Magaz* 24(7)
- McManus ST (2007). Organizational Resilience in New Zealand, dissertation research of the Civil Engineer Department of the Canterbury University, New Zealand.
- Sheffi Y, Rice Jr JB (2005). A Supply Chain View of the Resilient Enterprise. *MIT Sloan Manage Rev*, 47(1): 41–48
- Sanchis R, Poler R (2010). Medición de la Resiliencia Empresarial ante Eventos Disruptivos. Una Revisión del Estado del Arte. Proceedings of 5th International Conference on Industrial Engineering and Industrial Management, Cartagena.
- Svensson G (2000). Conceptual framework for the analysis of vulnerability in supply chains. *Int J Phys Distr & Logs Manage* 30(9): 731–749