Quick Response to Fluctuations in Supply Chains: A Review

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Abstract— Over the last forty years, the multiplicity of available products and the acceleration of innovation has made business environment and market much more uncertain for the companies. Although businesses have visibly understood the potential of supply chain management as a competitive advantage, the shift in market requires the implementation of new supply chain strategies which answer perfectly to this shift in markets. In this context, agility, as one of the main new strategies adaptable in the new market environment, refers to a company's ability to get advantage of new opportunities in the current volatile market. This paper, first reviews the concept of agility, studied by literature of supply chain management, and highlights the positive outcomes of such strategy on delivering added value to customers.

Index Terms— flexibility, agility, leagile supply chains, responsiveness

I. INTRODUCTION

The efficiency and effectiveness of one's supply chain may require a shift in strategy with a view to create added value to final customers as well as increasing performance and market shares. The old adage «cost reduction / reduced waste» is not sufficient anymore to match customers' changing needs. Furthermore, competition between companies, especially in the high technology, automobile or apparel industries keeps increasing due to the even shorter life cycles of their products. As such, customers are offered multiple choices which drive them to switch from one brand to another more easily.

In such hostile environment, it is important for many companies to consider new supply chain strategies in order to gain competitive advantages over their fierce competitors. Designing a more market-oriented supply chain based on responsiveness and flexibility appears to be an appropriate solution in order to respond the closest as possible to market demand. For many experts on the subject, such competitive advantage can be achieved through an agile-based supply chain strategy.

This paper reviews the concept of agility and highlights the positive outcomes of such strategy on delivering added value to customers. To do this, the reminder of the paper is organized as follow. In the first part of this paper, we will define the concepts of responsiveness and agility and explain why integrating those new parameters is crucial to the survival of businesses nowadays. Then, we will focus on the notions of customer value and customer retention and try to explain to what extent agility is a key tool for increasing service levels. The third part will aim at describing the characteristics of the agile supply chain based on literature, as well as distinguishing the different scales of flexibility within companies.

II. AGILITY AND RESPONSIVNESS

In times of global financial crisis and market uncertainty, flexibility and responsiveness become more and more significant ([1]). Besides, organizations should seek for a more customer-oriented supply chain given the increase in environmental turbulences and changing conditions in competition ([2]). In the post WWII era, price was the main buying factor for customer: quality and speed were not so important. Companies were driven by a single objective: mass production through manufacturing automation at the lowest price. Besides, availability of goods was more important than product innovations ([3]). Conventional supply-chains, which are economy of scale-based supply chains tend to concentrate on short term gains instead of long term profitability, as well as neglecting the need for innovation to match customers' needs ([4]). Holweg ([1]) underlines that conventional supply chain strategies, which frameworks and structures were built in time of relative stability, are not suitable in the new fluctuating market. ([5]) argues that "agility has become more critical in the past few years because sudden shocks to supply chains have become frequent. The terrorist attack in New York in 2001, the dockworkers' strike in California in 2002, and the SARS epidemic in Asia in 2003, for instance, disrupted many companies' supply chains". Lee ([5]) recognizes natural disasters and computer viruses as additional current sources of uncertainty. He also argues that most organizations are unable to draw contingency plans when crisis outbreak.

Abrahamsson et al. ([6]), insists on the fact that the business environment in the beginning of the XXIrst century has been dramatically marked by the 2008 recession. Such recession deeply weakened companies and competition escalated. In few words : "Rapid technological change, combined with global shifts in spending power, and the continuing problem of over-

Manuscript received July 1, 2017; revised August 18, 2017.

capacity in many industries make for a potent recipe for continued uncertainty in the business environment" ([6]).

Eventually, after studying responsiveness variables in supply-chains, Tarafdar ([7]) brought to light that "the fact that there is not a significant direct relationship between a lean supply chain strategy and supply chain responsiveness leads us to conclude that a company that focuses only on waste elimination without considering the deployment of appropriate resources will not achieve supply chain benefits in terms of responsiveness.".

A. Agility

"Agility is a business-wide capability that embraces organizational structures, information systems, logistics processes, and, in particular, mindsets" ([8]). Christopher also insists on the flexible character of the agile supply chain, which is by essence, based on flexible manufacturing. According to [9], agility refers to a company's ability to use knowledge of the market and exchange of information within the supply chain network to get advantage of new opportunities in the current volatile market. This view is shared by [10], who think agility is based on the ability to face change, create virtual partnership and value skills and knowledge in order to deliver value to customers. The notion of quick response to change was particularly highlighted by [11] who identify change as being the main driving force behind an agile supply chain. Aitken and al. ([12]) argue that agility in the ability to provide flexible and quick response to the market demand through visibility of demand and synchronized operations. According to [13], agility is much more than flexibility and speed: it is the ability of mastering and synthesized the use of developed technologies and manufacturing techniques. That means agility is compatible with Lean supply chain, Computer Integrated Manufacturing, Business Process Reengineering and Total Quality Management for instance ([13]).

Barve ([2]), defines agility in supply chains as the ability to match both supply and demand at an affordable cost. Eventually, Christopher ([8]) stresses that market sensitiveness is the most important characteristic of the agile supply chain. Agarwal and Shankar ([14]) go further by asserting that the level of sensitiveness of a supply chain depends on the nature of relationship between partners and its ability to use IT tools.

Literature on supply chains has a lot to offer in terms of defining agility. However, we can easily spot the inherent drivers to agility which are: responding to customer's demand in the most accurate way through market data use, improve service levels through shorter delivery times, achieve higher levels of innovation through supply chain integration, better exchange of information and skills within one's supply chain, and finally, gain market shares on competitors through market responsiveness and flexibility.

B. Responsivness

A "responsive" supply-chain is customer-oriented, flexible and information intensive. Such supply chain is not only focused on cost-savings to compete, but rather interested in enlarging its customer base and long-term profitability. The responsive supply chain does not seek to improve efficiency alone. In that sense, the responsive supply chain management differs from the traditional supply chain management. It aims at enhancing customer value ([15]). These authors define the three objectives of responsiveness:

- 1) Improve agility in order to increase responsiveness to provide the customers with the right product at the right time in the right place, the use of accurate point-of-sales data being essential.
- 2) Centralizing and streamlining supply chain planning processes such as product development, with a view to increase flexibility.
- 3) Reduce risks such as supply chain disruptions or bottlenecks by getting rid of potential sources of internal and external problems.

On his side, Yusuf et al. ([11]) recognizes that responsiveness to social and environmental issues is an actual objective of the agility strategy.

Although responsiveness and agility are inseparable elements in the sense that an agile supply chain cannot be truly agile without being responsive, and a responsive supply chain must show features of agile supply chain such as flexibility, we must understand that they remain two different concepts. This is the point of [16] who differentiates four types of supply chain strategies: efficient, risk-hedging, responsive and agile. Α responsive supply chain is needed when supply uncertainty is low and demand uncertainty high. As well, a responsive supply chain is adaptable to rapid change in customer needs and its relationship with suppliers is based on time. The agile supply chain is needed when both supply and demand uncertainty are high. It is market oriented and features the ability to respond to a wide variety of market niches. A main difference with an ordinary supply chain is that supply chain relationship with suppliers is based on partnership.

Agility contributes greatly to the supply chain responsiveness: the more a company's supply chain features elements of agility, the more responsive its supply chain ([7]). Eventually, responsiveness can be considered as an indicator of how well the enterprise fulfills its supply chain strategy objectives.

III. CUSTOMER-VALUE ORIENTED SUPPLY CHAIN

Barve ([2]) defines customer satisfaction in few words: "Customer satisfaction is the customer's reaction to the value received from the purchase or utilization of the offering." According to author, customer satisfaction is one of the main objectives of the agile supply chain strategy. Besides, the author underlines that higher levels of logistics and trust between purchasing entities and their suppliers improves responsiveness and ultimately, customer satisfaction. Bloemer & Kasper ([17]) observed that customer satisfaction enhances customer loyalty. That means, a satisfied customer will be more prompt to repurchase a product or service from a specific provider. Customer satisfaction is necessarily linked to the concept of "the perfect order". Doug ([18]) puts words on such notion: "It's the ability to deliver to the customer an order that is complete, accurate, on time, and in perfect condition." The author insists on the fact that fulfilling the perfect order requires excellence across the supply chain from forecasting, planning to delivery: the ultimate goal of supply chain management. Christopher ([19]) noted that the power of the brand is not as strong as it used to be. In fact, marketing is all about getting and keeping customers. Indeed, consumers are more and more willing to accept substitutes which decreases customer loyalty to a specific brand. Besides, buyers expect higher levels of service from suppliers. As such, marketing services can not only focus on gaining market shares anymore. Now, customers expect both quality and immediate availability of products. That means marketing and logistics functions will have to work together to improve accuracy of orders and delivery speed. Christopher uses the concept of "lifetime value" to determine customer loyalty. He observed that the longer a customer stays loyal to a company, the less the focal company will spend on him to prevent him from buying somewhere else. That means retained customers are more profitable.

Realistically, it is hardly impossible to retain every single customer and achieve continuous perfect order. However, deeper understanding of market needs within the marketing function and better flexibility in logistics can prevent industrial customers and final consumers to remain loyal to a specific manufacturer.

A. Creating Customer Value

According to [19], the only way to be competitive advantage is delivering more customer value than their competitors. In other words, companies whose customers perceive more benefits comparing to cost when buying a product are more competitive. Achieve higher levels of customer value lies on continuous improvement.

Dong et al. ([20]) also believe that customer value is the ratio between the utility gained and the money spent for a customer when purchasing the product. As such, company should be aware that customer value is determined by customers' buying decisions. This is the point of [21], who argue that customer-value can be identify as Customer Perceived Value (CPV): "the balance between customers' perceived benefits and customer perceived sacrifices."

Evans ([22]) spots two different approaches to measure customer value: the first relates to the customer's perceived value of the product or service provided by a focal company. The second relates to the value the customer brings in the enterprise. Evans ([22]) stresses out that a company that scores higher customer value levels than its competitors as more chance for success and survival. As such, it is very much important to take actions if other market players show better customer perceived value levels in order to remain competitive. According to [23], a main threat for an organization is the "perception gap" that exists between the company and its customers: what the company thinks a customer is expecting does not necessarily match the real customers' needs. Eventually, Lo et al. ([24]) make the following distinction between "industrial customers and consumers, the former being companies that purchase products for their core businesses, and the latter individuals who buy products for their own use". Indeed, these two types of customers may not have the same expectations or concerns regarding product or service. In that sense, organizations must acquire both industrial customerperceived values knowledge (ICPV) and consumerperceived value knowledge (DCPV) which are the two elements of CPV ([24]).

B. Customer Satisfaction

One of the main goal of supply chain management in general should be to increase customer satisfaction at reduced overall cost ([25]). Barve ([2]) particularly insists on the fact that "flexibility in operations and delivery may enable the user to give customized service to its customers, particularly in special or non-routine requests". Besides, the author categorizes market sensitivity and responsiveness as factors of agility. Coupled to higher levels of logistics, market sensitivity has an extended impact on customer satisfaction. We can understand from ([2]) remarks that flexibility -which is one of the most important feature to agility- enhances customer satisfaction. Mason-Jones et al. ([26]) point out that velocity in supply chain is the main difference between a lean and agile supply chain. According to them, organizations featuring a lean supply chain tend to consider quality and reliability as order qualifiers. That means those last two elements are simply market qualifiers but not differentiators from the customer's perspective. However, in a lean supply chain, cost is perceived as an order winner: this would actually trigger the act of purchase from the buyer's perspective. On the other hand, a responsive supply chain will regard cost, service level, quality and lead time as order qualifiers and innovative features as order winners. In that sense, bringing innovative features to product or service is a competitive advantage for responsive supply chains. Eventually, Abrahamsson et al. ([6]) identify flow orientation and investments in flexibility and agility as prerequisites to fulfill customer needs in an era of volatility. Flow orientation is needed to score higher degree of effectiveness to increase velocity in supply chain with a view to answer rapidly changing customers' orders. Investing in agility assumes fostering resources allocation to external interfaces in an extended organization framework.

Those different but significantly compatible views on the role of responsiveness and agility in generating customer value leave us with the following conclusion: all at once, customer satisfaction is both a main driver and a prerequisite to agility. From now on, delivering value to customers is not only a matter of cost and short delivery time, whereas continuous innovation is considered a true differentiator.

IV. FOSTERING RESPONSIVENESS AND AGILITY IN SUPPLY CHAINS

A wide range of authors state that a fully agile strategy will not necessarily fit every kind of industries. Lee ([16]), Mason-Jones et al. ([26]) and Christopher ([8]) identified three different types of supply chain strategy: lean, leagile and agile. A lean supply chain aims at creating value from upstream to downstream the supply chain and improve efficiency through cost-savings and elimination of waste, by sticking to a specific production schedule. In other words, a lean supply chain is suitable in a rather predictable market environment. As we saw earlier, an agile supply chain aims at answering market expectations in fluctuating and uncertain markets, by fostering flexibility through higher levels of exchange of skills with partners. The agile supply chain promotes networking and partnership at both functional and managerial levels between partners. The agile supply chain is then based on accurate market knowledge and data. The leagile strategy, or hybrid strategy ([8]), is a combination of make-to-stock production and make-toorder production: products which demand is stable are produced on market forecasts, whereas products where demand is fluctuating are produced and assembled upon final customers' requirements. Lee ([16]) in particular, states that an agile supply chain is highly required in sector in which source of supply is unpredictable and innovation is the main driver such as the high-end personal computer or semi-conductor industries. On the other hand, a responsive or leagile supply chain would be appropriate in sectors that provides a variety of customized products to meet specific customers' tastes, such as the apparel and computer industries ([16]; [27]).

A. Characteristics of the Agile Supply Chain

Harrisson et al. ([28]) distinguished four complementary characteristics of the agile supply chain:

- 1) Information driven virtual integration;
- 2) Integrated process and management of performance are compulsory features ;
- 3) The agile supply chain is market sensitive and responsive;
- 4) Centralized and collaborative planning is a prerequisite to agility.

According to [11], the core concepts of agile manufacturing are:

- 1) Core competence management: upgrade core competencies through investments in training, seek new competencies through cooperation with partners, circulation of skills along the supply chain.
- The virtual enterprise: exploit Electronic Data Interchange tools to facilitate collaboration between stakeholders of the supply chain, virtual end-to-end partnership.
- Capability for reconfiguration: capability to make shift in focus and/or re-configure the organization or processes to meet changing market expectation rapidly, operational flexibility.
- 4) Knowledge driven enterprise: foster the circulation of knowledge along the supply chain with a view to increase technology and innovation, "people" as the most critical resource of the organization.

Christopher gathers those different points of view in a four ingredients set that characterizes the "truly agile" supply chain:

- Market sensitive : "The breakthroughs of the last decade in the form of efficient consumer response (ECR), and the use of information technology to capture data on demand direct from the point-ofsale or point-of-use, are now transforming the organization's ability to hear the voice of the market and to respond directly to it." ([8]);
- 2) Virtual enterprise : real demand information-based supply chain thanks to the EDI ;
- 3) Network-based supply chain: "the prizes will go to those organizations who can better structure, coordinate, and manage the relationships with their partners in a network committed to better, closer, and more agile relationships with their final customers." ([8])
- 4) Process integration: "collaborative working between buyers and suppliers, joint product development, common systems, and shared information." ([8]).
- B. Actions Required for the Implementation of an Agile Strategy of the Agile Supply Chain

Lee ([5]) distinguishes a set of mandatory rules to achieve agility. The first rule is to ensure continuous feed of data on changes in supply or demand between partners. This way, they can provide a quick response to market changes. Forrester ([29]) underlines that the circulation of accurate and timely demand data prevents the bull-whip effect. The second rule is to support collaborative relationships with both suppliers and customers. The expected outcome is companies working together to draw back up plans and re- design products and processes. Youn et al. ([30]), stress that an early involvement of suppliers in product development accelerates the production of innovative products. The third rule is to set up a postponement strategy: products that share the same parts or modules to be definitely configured as the very end of the production process. In few words, seek for a maximum standardization of sub-assemblies in order to reduce complexity and ensure better responsiveness to market demand in case of fluctuations. This manufacturing model is commonly used in the aeronautical industry. Boeing and Airbus planes are made prefigured sub-assemblies called "modules", of connected to each other via interfaces. Obsolete modules can be replaced by new performing ones with no need to modify the whole structure of the plane. Planes are assembled and configured on the customer's orders only ([31]). The fourth rule is to keep a small inventory of inexpensive components in case of supply outage. Lee ([5]) takes the example of H&M, which keeps small inventories of buttons, zips and other non-bulky components aside to avoid bottlenecks. The fifth rule consists in building a reliable logistics network that enables quick response. Ideally, companies should seek alliances with third-party logistics providers. This was the initiative of Amazon and General Motors to ensure faster delivery than competitors ([32]). The very last tip is to build a team of trained managers able to draw contingency plans when a problem comes up.

According to [33], six actions are required to set up an effective agility-based supply chain: standardization of sub-assemblies, delayed configuration, cross-functional team sharing, end-to-end integration of learning in the supply chain, empowerment of front-line decision making and product succession planning. Gehani ([33]) adds that production and marketing must work together to design product specifications and processes to manufacture the product. An early involvement of the marketers and manufacturers would prevent common downstream problems.

Barve ([2]) determined ten factors affecting agility in supply chains. The first factor is collaborative relationship with suppliers in order to increase flexibility and interdependence along the supply chain. The second factor is based on organization integration and willingness for improvement. Such integration can be achieve through cooperation between functions toward common goals. Integration can be optimize by EDI resources. Barve ([2]) sees lead-time reduction as a competitive advantage: minimum lead-time can be achieve through the adoption of the Just-in-time model, flexible manufacturing, automation and efficient technology tools. The author agrees with the importance of outsourcing logistics activities and fostering flexibility in systems. Flexibility enables organizations to provide customers with customized products. Then, flexibility in systems corresponds "the ability of a manufacturing system to cope with changes in the nature, mix, volume or timing of its activities". Top commitment of top managers, information sharing and trust are also defines as prerequisites features to the agile supply chain. Handfield & Bechtel ([34]) support this idea by stating that greater levels of trust between purchasers and manufacturers is the primary relational requirement for responsiveness. Cost and quality of services paired to customer satisfaction are also successful factors of an agility-based supply chain.

Christopher ([19]) established seven basic principles of the agile supply chain:

- 1) Synchronization of activities through shared information: a single schedule must be designed for the entire supply chain based on process alignment and shared information.
- 2) Business Process Re-engineering to simplify the organizational processes: Christopher highlights that the fact that "a large proportion of the end-toend time is non value adding. In other word, time is being spent on activities that topically create cost but do not create a benefit to the customer". The author specifically underlines that time spent on inventory lengthens process time. Fostering processes simultaneity through BPR and reduce complexity by eliminating non-adding value activities is a priority.
- 3) Partnership with supplier to reduce in bound leadtime: "substituting information for inventory" through the implementation of Vendor Managed

Inventory practices is key. The supplier is responsible for the replenishment in exchange of sales and inventory data from the purchaser. This leads to a better use of capacity and reduction of safety stocks for suppliers, as well as greater levels of reliability and availability for customers.

- 4) *Reducing complexity of the products*: seeking greater commonality of components and simplify products variety.
- 5) *Postponement strategy*: late configuration of the product to make sure the products that are available corresponds to customers' real expectations. This also help to reduce inventory costs of finished products.
- 6) *Managing processes, not functions*: switch from a "division of labor model" to the creation of cross-functional processes managed by interdisciplinary teams.
- 7) The use of performance metrics: Christopher adds a new apparatus to the implementation of agility. He underlines the importance of performance measurement to encourage agile practices. He recommends the use of time-based metrics to improve cycle-time and set-up time reduction. Metrics such as perfect order achievement and time-to-market/time-to-volume are also highly beneficial in order to respond to fast-changing technologies.

Those arguments are completed by [35] who characterize data accuracy and New Product Introduction as two of the fifteen variables influencing supply chain agility. Data accuracy, originally based on sale data instead of forecasts, must be maintained along the supply chain in order to avoid distortions such as the bullwhip effect. Besides, the ability for companies to come up with innovative products is a competitive skill, especially in new technology industries where products life cycles shorten.

Finally, in the following table, using the literature of agile supply chain, we provide a set of actions necessary to achieve agility in supply chains.

TABLE I. A SET OF ACTIONS TO ACHIEVE AGILITY

	-	
Principles	Tools	Authors
End-to-end	EDI ;	[12]; [14];
continuous and	Market-sensing ;	[35]; [2];
accurate feed of	Point of-sales data	[27]; [29];
demand data by		[28]; [5]; [9]
virtual		
integration		
Collaborative	Trust between partners ;	[2]; [34];
relationships	Virtual enterprise ;	[36]; [37];
with suppliers	EDI	[5]; [30];
and customers		[11]; [15]
Delayed	Postponement strategy: make to-	[38]; 19];
configuration	order, configure-to-order model	[39]
Reduced product	Reduce configurations ;	[19]; [40];
complexity	standardization of subassemblies	[31]
Dependable	Outsourcing to 3 rd party provider	[32]; [16]
logistics system		
Organization	Culture of change ; cooperation	[12];
integration and	between functions ; common goals ;	[35]; [8];
willingness for	circulation of knowledge ; single	[28]; [5];
improvement	production planning and process	[9];[39];
-	alignment	[41];

		[15]; [11]
Cross-functional	Decentralized decision-making;	[8]; [19];
team sharing	teams across company's borders;	[37]; [11]
	end-to-end shared information	
Lead-time	Advanced manufacturing ;	[2]; [19];
reduction	automation ; VMI ; Just-in time ;	[42]; [15];
	simultaneity of activities; BPR;	[43]; [44]
	elimination of nonvalue adding	
Ten menescrial	Eall commitment of monogone in	[2], [10],
Top manageriai	Full communent of managers in	[2]; [19];
competences	strategy to the managers approaching	[43]; [11]
New Decident	Customer driven innevention :	[25], [9],
Introduction	technology everypass type of	[33]; [8];
Introduction	surrent technologies , technologies	[22];[33];
	watch	[11]
Customer	Wider range of customer service	[35]. [8].
satisfaction and	capabilities (warranty etc.)	$[46] \cdot [47] \cdot$
quality of service	eupuolities (warranty etc.)	[10], [17],
Ouality over	Short development cycle time : first	[35]; [48];
product life	time right design ; value adding	[49];
1	products ; Total Quality	[13]; [11]
	Management ; long-term	
	relationships between supplier-	
	customer	
Core competence	Circulation of skills through	[10]; [13];
management	cooperation ; investment in	[11]
	training ; people as critical	
	ressource ; business practices	
	difficult to copy	
Minimizing	Identification of risks in demand	[6]; [8]; [5];
uncertainty	and supply ; teams of skilled	[39]; 15]
	managers to draw up back up	
1	plans; keep small inventories of	
TT C	plans ; keep small inventories of inexpensive components	[10] [20]
Use of	plans ; keep small inventories of inexpensive components Time-based/ time-to market/perfect	[19]; [28]
Use of performance	plans ; keep small inventories of inexpensive components Time-based/ time-to market/perfect order achievement metrics ;	[19]; [28]
Use of performance metrics	plans ; keep small inventories of inexpensive components Time-based/ time-to market/perfect order achievement metrics ; management of performance	[19]; [28]
Use of performance metrics Empowerment of	plans ; keep small inventories of inexpensive components Time-based/ time-to market/perfect order achievement metrics ; management of performance Encourage employees to solve	[19]; [28] [33]; [50]
Use of performance metrics Empowerment of front-line	plans ; keep small inventories of inexpensive components Time-based/ time-to market/perfect order achievement metrics ; management of performance Encourage employees to solve customer problems	[19]; [28]

V. CONCLUSION

The aim of this paper was to show how organizations can deliver higher value to customers by injecting agility in its supply chains. According to literature, an agile supply chain is better able to respond to fluctuating market demand, both in terms of the mix or volume of products. However, agility also aims at dealing with disturbances in supply streams. As such, a company's ability to answer customer demands is undeniably linked to ability to make up contingency plans is case of supply crisis. Upon reviewing the solutions provided by supplychain researchers, we intended to draw a detailed set of actions to be taken to perform higher levels of agility.

Although the recommended techniques seem to work on paper, we saw that an agile supply chain remain quite vulnerable in real life. Indeed, behavioral factors such as resistance to change and lack of managerial commitment can dramatically threaten the continuance a newly established agile supply-chain. This leads us to the conclusion that building agility must be contemplated as a continuous improvement, to which both technical and managerial functions must be fully committed to.

Eventually, agility in supply-chain is a competitive advantage, it might not be the only ingredient required to join the small circle of the Triple-A supply chains ([5]).

ACKNOWLEDGMENTS

This project is funded by the European Union. Europe is committed in Normandy with the European Regional Development Fund. This document commits only the University of Le Havre, the managing authority is not liable for any use that may be made of the information in this publication.

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