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The combined impact of Blockchain and Omnichannel on Logistics and Last Mile delivery: an empirical investigation.

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Section 1

1. Introduction

Today's companies interface and interact in a dynamic market which is undergoing a radical transformation driven and punctuated by the accelerating pace at which digitalization and technological developments are advancing (Rachinger et al., 2018). Managers must be ready to understand the changes that innovations bring with them and be proactive in adopting or even anticipating them (Christensen et al., 2015). Only in this way firms can survive to the destructive wave of new trends and face competitors operating in the same sector but with totally different business models (e.g. Uber or Airbnb). E-commerce, the Internet of things, artificial intelligence, crypto-payment, robotics, cloud systems, augmented reality, new energetic resources are some of the phenomena that are revolutionizing the way of doing business and reshaping entire corporate functions and departments (Manners-Bell & Lyon, 2019). In this landscape, this research focuses on what is happening to the supply chain (SC) due to the emergence of blockchain and the increasingly widespread adoption of the omnichannel approach.

Based on the consumer-centric vision, which is now at the heart of the firms' strategies, omnichannel involves managing synergetically multiple channels and touchpoints in order to enhance consumers' experience and to optimize channels performance (Verhoef et al., 2015). However, achieving this goal is conditioned by the necessity to establish trust, transparency and traceability throughout the SC, strengthening the relationships between the partners and enabling a full integration of all firms' multiple heterogeneous channels. The blockchain seems to have the potential to respond to this requirement. Although until recently it was almost unknown and its use restricted to the financial services field, nowadays it is beginning to appeal more and more to managers who are beginning to perceive its positive effects on the SC (Hackius & Petersen, 2017). This distributed database, shared among and agreed by a peer-to-peer network (Seebacher & Schüritz, 2017) can accelerate logistics operations and processes, making them more efficient and effective and less bureaucratic too. At the same time, the literature and practitioners are still doubtful about blockchain's actual applicability and beneficial effects on the SC due to insufficient practical successful cases (Yli-Huumo et al., 2016). As a result, managers are skeptical of investing in something they do not have a full awareness and assurance about.

Therefore, the purpose of this paper is twofold. On the one hand we would like to provide an empirical contribution to the existing literature and simultaneously to support the blockchain adoption creating a model within which we study, considering it as an exogenous variable, both its contribution to omnichannel strategies and how the latter and this disruptive technology can improve logistics flows along the SC, with particular attention to the last mile segment. In order to demonstrate the convenience of an optimal supply chain management, we also analyze how these variables can drive higher economic performances. To answer to our conjectures, we design a Likert scale-based questionnaire to collect enough data to corroborate or contradict our assumptions. The sample obtained consists of a total of 157 firms from all over the world, represented by supply chain, logistics, operation but also distribution and sales managers, working especially for either manufacturers or retailers. The resulting information are analyzed through Partial Least Square - Path Modeling. To asses our model we rely on the examination of internal consistency, convergent and discriminant validity. The findings of our analysis show that for managers blockchain is a valuable option to reinforce omnichannel strategies. Companies can exploit the synergies arising from omnichannel and the blockchain to deploy even more efficient and effective logistical strategies that considerably diminish the difficult-to-manage last mile delivery. The increased economic performances provided by the mechanism of our framework is an incentive for practitioners to invest in logistics systems, also through new technologies such as blockchain or new strategies such as omnichannel.

The remainder of this dissertation is structured as follows. In section 2 we review the literature on the target variables of our investigation (i.e. blockchain, omnichannel, logistics and last mile) and we also present which are our theoretical hypotheses to be empirically verified. In section 3 we describe the processes to collect and to analyze the data from our sample, while in in section 4 we show the final empirical results and give insights about which hypotheses are confirmed and which are not. Section 5 is dedicated to the discussion of the managerial implications and literature contribution of our findings. In the last part, section 6, we expose the conclusions and limitations of our work.

Section 2

2. Literature

2.1 Literature review and hypotheses development

The companies' tendency to integrate offline channels and online channels in order to provide a seamless customer experience (Levy et al., 2013) finds its roots both in the continuous technological development (Brynjolfsson et al., 2013), the rapid changes related to consumers' purchasing habits (Yurova et al. 2016), as well as the benefits that the omnichannel offers in terms of sales growth (Ishfaq et al., 2016), brand loyalty and customer satisfaction (Chen et al., 2018). Although the literature has deeply detailed the possible advantages and potential applications of omnichannel (e.g. Brynjolfsson et al., 2013), also through successful cases such as Tesco and Macy's (Tetteh & Xu, 2014), firms are still struggling with the implementation of efficient and successful omnichannel strategies (Berg et al., 2015). Companies operating in an omnichannel context deal with high supply chain complexity. Most of the problems emerged from omnichannel strategies link to the lack of transparency (Abeyratne & Monfared, 2016), the need for fast deliveries, flexible orders, and the compliance with regulations or quality standards (Welfare, 2019).

The blockchain technology can be an effective solution to the current issues existing in omnichannel frameworks. Blockchain is defined as “a distributed digital ledger of transactions that cannot be tampered with due to the use of cryptographic methods” (Pilkington, 2016). This system benefits from both the absence of a central authority replaced by a peer-2-peer-network, a public-private-key cryptography as well as a consensus-based algorithm, which allow to validate a new block of transactions only if the members’ consensus is reached (Hackius & Petersen, 2017). These three elements make the blockchain a decentralized, verified, and immutable system (Robinson, 2018), providing the basis of its potential business benefits. Although the blockchain finds several applications and heterogeneous executions, it is still in its early phase of development in SC management.

Firms looking at the development of an omnichannel strategy can evaluate the adoption of blockchain to mitigate all SC inefficiencies. The literature has highlighted how blockchain can enhance the economic and operational value of all the activities across the SC (Ksherti, 2018) from manufacturing to warehousing, transportation and logistics (van Hoek, 2019). By implementing blockchain technology all different partners involved in the network (e.g. retailers and customers) share the same verified information (Hackius & Petersen, 2017), allowing the optimization of the omnichannel strategy and eliminating the need for trust and transparency among omnichannel parties. Blockchain enables to monitor products throughout each stage of the SC and over the different channels (Welfare, 2019). Therefore, blockchain promises to revolutionize the omnichannel landscape. By adopting an omnichannel approach, consumers can purchase from their favorite channels and make different choices in terms of delivery channel, payment methods, and delivery time. Blockchain can be a driver to monitor all journey of the products, to collect all relative data, and use them to overcome the SC inefficiencies over all channels (Clark, 2017).

Some business cases have already demonstrated the success of blockchain technology to improve the omnichannel. Walmart has chosen to use blockchain technology to increase the transparency of its food supply chain, enabling full products traceability over the globe and across all multi-channel used. Initially, this system was tested to track the origin of mangoes sold in its stores in America and to monitor pork sold in Chinese stores. In the former case, the result was a considerable reduction in the time needed to check the origin of the mangoes: no longer seven days, but only 2.2 seconds. This improvement allows the sales of mangoes to quickly develop in all SC channels. In the latter case, blockchain allowed the uploading of certificates of authenticity attesting the quality of the meat to all stakeholders and consumers purchasing the products in all channels. Within the food sector, higher transparency and traceability help to prevent dangerous situations such as the distribution of a product contaminated by bacteria and therefore the outbreak of foodborne illnesses (Hyperledger, 2019), encouraging consumers to use atypical channels also for purchasing food. Similarly, Carrefour uses blockchain technology to trace the production of free-range chicken. Through the scanning of a special code on the package, consumers can obtain all the information about the chickens independent of the channel that consumers use to finalize their purchases (Capgemini, 2018). Barilla, in collaboration with IBM, is now testing blockchain to control every moment of the basil production chain to guarantee the quality of the "Made in Italy" (Prandelli & Verona, 2019). This information will be available to all consumers in all channels in which Barilla's products will be made available. Apart from the food chain, the blockchain is also gaining ground in other sectors such as the fashion world. The challenge here is the risk of counterfeit products. This is the reason why companies such as LVMH are experimenting with the use of the blockchain, within brands such as Louis Vuitton, to allow consumers to trace the entire history of the products, from the raw materials used, to manufacturing and distribution. The blockchain can then boost the use of omnichannel solutions, for products that are generally sold off only.

The aforementioned examples highlight how the blockchain streamlines the processes in an omni-distribution channel environment (Tetteh & Xu, 2014). In addition, these cases demonstrate how blockchain becomes the cornerstone of the entire omnichannel consumers' experience, which becomes stimulating, secure, simple and agile. Although blockchain is a potential technology to improve omnichannel strategies, there is still a lack of evidence and empirical research highlighting its true operational and economic benefits. Accordingly, we hypothesize that:

H_1: Investments in blockchain have a positive impact on omnichannel management.

The enthusiasm generated by the high expectations that blockchain is raising, is partly held back by the absence of sufficient practical evidence of its advantages. Being a rather new technology, there is still not only little knowledge of it but also confusion about its possible applications, especially in logistics (Dobrovnik et al., 2018). Logistics is the strategic management of the movements and storage of raw materials, semi-processed, and finished products from suppliers, through focal company, and consumers (Christopher, 2016). It encompasses a very diversified portfolio of business activities (de Carvalho & Campomar, 2014) ranging from inventory management, order fulfilment, warehousing, management of third-party logistics services providers but including also production planning and scheduling as well as customer service activities. Due to the significant number of processes that fall within the field of logistics, Bowersox and Closs (2001) identified four distinct areas: supplier relations and storage management; production; distribution, and reserve logistics. Firms operating in a more complex business environment, where multiple interconnected channels are used, have to tailor their logistics processes. Having an efficient and effective integrated logistics system becomes necessary in order to prevent that the management of the processes could be too expensive and troublesome. Frequent delays in delivery times, loss of documentation, human errors, but also uncertainty about the origin of raw materials are some of the business risks that logistics can mitigate (Tijan et al., 2019). Integrating logistics with blockchain technology can help overcoming these challenges.

The blockchain mechanism enables to monitor the product throughout the supply chain, ensuring that data are stored as transactions, visible to all members and verifiable without the need for intermediation (Dobrovnik et al., 2018). Thereby collaboration among all stakeholders in the SC is enhanced by full information sharing (Tijan et al., 2019) and full visibility (Litke et al., 2019). In this way, time-consuming and expensive logistics processes can be speeded up, streamlined and made more secure. The use of smart contracts, for instance, promotes compliance with agreements between the parties and accelerates payment procedures. Nevertheless, the literature has expressed concerns about the application of the blockchain. Francisco et al. (2018) explain that the benefits of the blockchain are especially evident when the members within the network are substantial. Shermin (2017) points out that it is complex for companies with different levels of technology to collaborate on the implementation of blockchain, while Dubrovnik et al. (2018) highlight possible problems that can occur among SC partners at the regulatory or consensus level. This dichotomy between the difficulties linked to the issues of establishing the blockchain and the potential operational benefits, together with the lack of their empirical evidence, induce us to hypothesise that:

H_2: Investments in blockchain have a positive impact on logistics management.

While the blockchain is expected to be one of the key drivers to improve the corporate logistics sector, another key driver could be omnichannel. Weiland (2016) illustrates how the wave of technological progress, characterized by the advent of the internet and the emergence of mobile phones first and of social networks later, has stimulated companies to explore the use of new sales channels. Defining as multichannel, this approach consists of companies operating different channels, which are independent from each other (Beck & Rygl, 2015). Shareef et al. (2016) refer to these channels as separate silos, not exchanging information and having their own separate operational and logistical processes (Hübner et al., 2016). Consequently, the synergies due to a single, integrated and data-driven management of the channels' activities are not exploited and drawbacks like cannibalization arise. Academics agree that multichannel operational deficiencies can be solved by switching to omnichannel. Brynjolfsson et al. (2013) explain that this approach facilitates fulfillment processes by eliminating barriers among channel and thereby enabling communication across them and the creation of a unique set of operations, logistics and inventory. Hübner et al. (2016) also develop a comprehensive framework that highlights the enhancements that an omnichannel logistics system can bring in the areas of forward and backward distribution, inventory management, picking across channels, assortment and that identifies IT and organizational systems as fundamental for an efficient and effective logistics integration.

Although on the one hand literature is quite unanimous on the advantages offered by omnichannel in logistics, on the other hand it also illustrates the problems of an omnichannel logistics system. Wieland (2016) explains how full integration between channels and the agility of logistical processes can only be achieved through reliable and secure data shared with all SC components and he also warns about the importance of creating full integration between all channels, thus ensuring not to favor the development of one channel more than the other. Hübner et al. (2016) point out omnichannel costs related problems due to the necessary large capital investments in technologies, expertise and resources, while Larke et al. (2018) instead focus on how omnichannel implementation strategy is a very time-consuming project, requiring substantial changes throughout the SC and involving significant challenges.

The discrepancy between the advantages and disadvantages provided by omnichannel in logistics, together with the small number of examples of companies that have fully and successfully implemented logistical interfaces among channels, induces us to better explore this field. Accordingly, we hypothesize that:

H_3: Investments in omnichannel have a positive impact on logistics management.

One of the primary and toughest issues that logistics managers have to master is the handling of the last mile phase. Lim et al. (2018) depict last mile as “the last stretch of a business-to-consumer parcel delivery service, taking place from the order penetration point to the final consignee’s preferred destination point”. In other words, it means delivering the product into the consumer's hands, regardless of the channel through which the product was purchased (e.g. company website or retailer store) and the delivery destination (e.g. home, office or a locker) (Antony Welfare, 2019). Although the last mile has gained significant interest from scholars especially during the last few years, due to the growth of e-commerce, academic research has not refrained to analyze it from different perspectives. Notably, literature is attempting to answer to the necessity of making last mile delivery as efficient as possible. Potential solutions to optimize the last mile are discussed by authors like Iwan et al. (2016) who propose the use of parcel lockers, placed for example in buildings or shops, which enable the customers to pick up their products safely where they prefer and at their most convenient time (e.g. Amazon). Besides this option, new solutions such as crowdsourcing logistics (Wang et al., 2016) or collection and delivery points (Kedia et al., 2020) have been introduced by companies. Advanced technology vehicles are perceived as a possible answer to last mile inefficiencies too. Deng et al. (2020) propose the introduction of drones to effect deliveries and to decrease the number of not fulfilled ones. Literature suggests also the optimization of the traditional delivery method to achieve last mile efficiency. Geetha et al.’s (2013) studies suggest alternative solutions for the management of the vehicle routing problem, while Abdulkader et al. (2018) frame the issue of finding the optimal route within an omnichannel system. Beyond logistical efficiency, some authors highlight how a well-managed last mile can increase consumer satisfaction and loyalty (Chou & Lu, 2009), while others underline the problems related to the environmental sustainability of online commerce (Bertram & Chi, 2018). From what has been said, it is evident that a careful planning of last mile logistics is of interest both for companies and consumers (Lim et al. 2018). Indeed, an optimal management of the last mile process can mitigate those shortcomings such as transportation costs, delivery costs, delays, missed deliveries and it can translate into higher economic performance and customer-related advantages (e.g. brand loyalty). Within this context, our goal is to demonstrate that logistics system can be the key to make the last mile delivery process as efficient and manageable as possible. Accordingly, we hypotheses that:

H_4: Investments in logistics have a positive impact on last mile delivery.

For those players active in the marketplace without a physical footprint, but through online commerce only, like Amazon and Alibaba, setting up and controlling all the processes linked to the last mile is crucial. Hübner et al. (2016) identify four variables shaping the last mile dimension and the issues associated with each of them: the delivery mode, the delivery time, the delivery area and return logistics. The former denotes all the procedures that a company can carry out in order to provide the product to its customers, including attended home delivery, unattended home delivery, reception box, collection-and-delivery points and crowd shipping. Wang et al. (2014) develop a mathematical model to illustrate how the operational efficiency and costs of AHD, RB and CDPs can change across different scenarios, while Hübner et al. (2016) carry out a qualitative assessment of the delivery options, emphasizing the issues associated with each of them. The optimization of delivery time is one of the cornerstones of last mile management. Its efficient planning translates both into higher customer satisfaction and effective costs reduction (Bushuev & Guiffrida, 2012). Firms have to take into account not only internal factors (e.g. optimal delivery windows offer) but also external ones (e.g. travel time uncertainty) (Agatz et al., 2011). The last mile logistics has to be designed also in relation to the area in which the delivery service is to be executed. Zeng (2018) points out that despite the continuous expansion of e-commerce in China's rural areas, the last mile still represents a serious hurdle due to inadequate infrastructure, insufficient participation of logistical operators, that are distant from each other and that work with poor technology system, and the resulting significant costs. The final stage of last mile deals with the reverse logistics. Traditional retailers offer to their clients the possibility of changing or giving back the product instantly and directly in the store (Weber & Badenhorst-Weiss, 2018), while for online sellers it is less straightforward, more expensive and can result in customer complaints. In addition, the intricacies of the last mile can be exacerbated by the company's business. Weber et al. (2018), for example, analyze how the temperature control is essential for e-grocery retailers. The challenges of the delivery process concern digital firms as well as omnichannel companies. Nevertheless, when a consumer buys from the latter, a wide choice of purchasing services can be proposed (e.g. buy online, home delivery; buy online, pick up in-store; buy online, delivery in a locker). Bell et al. (2014) indicate that the introduction of "buy online, pick up in-store" has triggered a decline in online sales and an increase in offline ones within the American market, especially for those items whose attributes are complicated to sense virtually. Therefore, omnichannel strategies can expand the segment of clients not choosing home delivery, slimming last mile operations. This potential enhancement, provided by omnichannel, has no evidence and empirical research demonstrating its effectiveness. Accordingly, we hypothesize that:

H_5: Investments in omnichannel have a positive impact on last mile delivery.

While on the one hand the omnichannel promises to have the potential to reduce the criticalities and the uncertainties connected to the final mile, on the other hand a more tangible answer is already being given by technology. The growing pace of technological progress has pushed companies to invest in new solutions and mediums to operate the delivery chain. A comprehensive overview of the cutting-edge gimmicks, their strengths and their cost-effectiveness has been provided by Mangiaracina et al (2019). Accordingly, the employment of increasingly advanced robots in conjunction with new delivery techniques, such as mapping customer behavior and dynamic pricing, is deeply modifying the last mile outlook. Following this direction, McKinsey & Company (2018) forecasts that over the next twenty years there will be a gradual adoption of sophisticated, and probably disruptive, technologies which will revolutionize last mile delivery. Among the most promising strategies to solve the last mile management problems, there is the use of blockchain technology. Despite literature is quite silent in this regard, the examination of some practical examples and some scholars' researches can be considered as a starting point to foresee the future possible applications of the blockchain in the final mile. Pournader et al. (2019) consider blockchain as a useful driver for establishing trust between all partners, which can come into play in transporting and delivering goods (e.g. third services logistics providers), enabling a common sharing of accountable transaction data. To reduce costs and times delivery, Walmart has filed a patent for a blockchain-based drones system (Hanbury, 2018). The idea is to use a blockchain keys to allow drones to exchange information with each other and with other delivery vehicles in order to enable them to swap parcels, eliminating the need of paperwork and improving package tracking transparency and delivery security (Dukowitz, 2019). Last mile delivery problems also stem from the traceability of the product. In particular for products easily perishable, like foodstuff, the delivery has to be properly planned and managed. Companies must ensure that consumers receive their purchases in optimal conditions. By using blockchain, SC partners can have access to a reliable and secure record of data transactions and monitor the status of the product step by step, going back to the origin of the inefficiencies more quickly. In this perspective IBM (2018) gave life to IBM Food Trust, aiming at "making the food safer and smarter from farm to fork". The cases illustrated are the proof that blockchain technology can be a powerful aid in successfully handling last mile operations. Nevertheless, as we have previously said, the obstacles and doubts related to its application and functioning lead companies to be still uncertain and reluctant about its effectiveness (Francisco et al., 2018; Shermin 2017; Dubrovnik et al., 2018). Therefore, even if blockchain is a potential technology to improve last mile phase, there is still a lack of evidence and empirical research highlighting its true operational and economic benefits. Accordingly, we hypothesize that:

H_6: Investments in blockchain have a positive impact on last mile delivery.

Offering home delivery services is a common practice for those purely e-commerce businesses. Nonetheless, a continuously growing number of companies selling offline are now moving into the virtual sale world, aligning their traditional channels with the digital ones, in order to grab a profitable slice of the online buyers (Ishfaq et al., 2016). Firms' efforts of becoming omnichannel are motivated, among other things, precisely by the chance of thriving economically in a strongly changing market environment. McKinsey&Company (2019) apparel industry report reveals that omnichannel shoppers accounts for 30% of the total amount of consumers and how this digit is booming. Bain-Altagamma (2019) introduces the expression "phy-gital" to connote the actual luxury goods consumers, estimating an increase in the use of online channels of 22% by 2020 in this sector. The way of purchasing groceries is going under a continuous digitalization too, with retailers more and more committed to fulfilling online sales (Wollenburg et al., 2018). The changeover to omnichannel, to exploit its economic benefits, does not take place without substantial changes. Berman and Thelen (2018) explain that an efficient, effective and profitable omnichannel strategy is fully accomplished when companies handle their channels in a homogeneous way, cross-selling to customers across all of them and thus offering several different shopping options (such as buy online/pick up in store, buy online/home delivery, buy online/return to store and so on). To ensure such services do not turn from a profit opportunity to insurmountable costs, a scrupulous and meticulous planning of logistics and operations is required.

Literature is broadly in agreement about the essential role played by logistics in driving corporate profitability. Rădulescu et al. (2012) argue how the management of the corporate logistical system is a strategic factor to achieve competitive advantage in terms of profitability. Miller et al. (2015) carry out an extensive investigation on a large sample of firms to analyze in which way they manage outbound logistics in order to demonstrate how it affects profitability. Zimon et al (2015) stresses the importance of minimizing costs by optimizing and managing the inventory accordingly. In addition, Colicev et al. (2016) highlight the influence of successful operational performances, stemming from high quality, lead times and flexibility, on companies' economic results.

Researchers are mainly concerned about the high operating costs and the challenges involved by last mile logistics. Lim et al. (2018) classify delivery processes among the most expensive and inefficient in the entire SC and therefore among the most damaging for profitability. Vakulenko et al. (2019) highlight the struggle and the expensiveness to satisfy omnichannel customers, offering customized delivery services in terms of delivery times, locations, payment methods as well as granting them optimal returns conditions. Nevertheless, a well-managed last mile can be a key element in building customer loyalty and encouraging repurchasing (Capgemini, 2018).

Literature is also exploring how new technologies, such as blockchain can contribute to companies' economic survival in the omnichannel scenario. Ko et. al (2018) empirically demonstrate how blockchain technology, enabling real-time transparency and the reducing costs (e.g. eliminating the necessity of paperwork), can improve the overall business profitability, while Carter et al. (2018) emphasizes the economic and operational benefits of blockchain across SC. Likewise, however, the literature still lacks of sufficient practical cases to prove the effectiveness of blockchain. Within this context, through our research we want to contribute to the existing literature by providing empirical support on how the aforementioned elements (omnichannel, logistics, last mile and blockchain) can positively influence company profitability. Accordingly, we hypothesize that:

H_7: Investments in omnichannel have a positive impact on economic performance.

H_8: Investments in logistics have a positive impact on economic performance.

H_9: Investments in last mile delivery have a positive impact on economic performance.

H_{10}: Investments in blockchain have a positive impact on economic performance.

Figure 1 summarizes the research hypotheses.

2.2 Testing the indirect effects

The purpose of our research does not limit to the previously presented hypothesis analysis. We also propose to investigate the indirect effects that exist between Blockchain, Omnichannel, Logistics, Last Mile management and Economic performance. By indirect effects we mean the second order effects, which are generated among the variables within our model. Accordingly, we hypothesize that:

H_{2b}: Investments in blockchain have a positive indirect effect on logistics management.

H_{5b}: Investments in omnichannel have a positive indirect effect on last mile delivery.

H_{6b}: Investments in blockchain have a positive indirect effect on last mile delivery.

H_{7b}: Investments in omnichannel have a positive indirect effect on economic performance.

H_{8b}: Investments in logistics have a positive indirect effect on economic performance.

H_{10b}: Investments in blockchain have a positive indirect effect on economic performance.

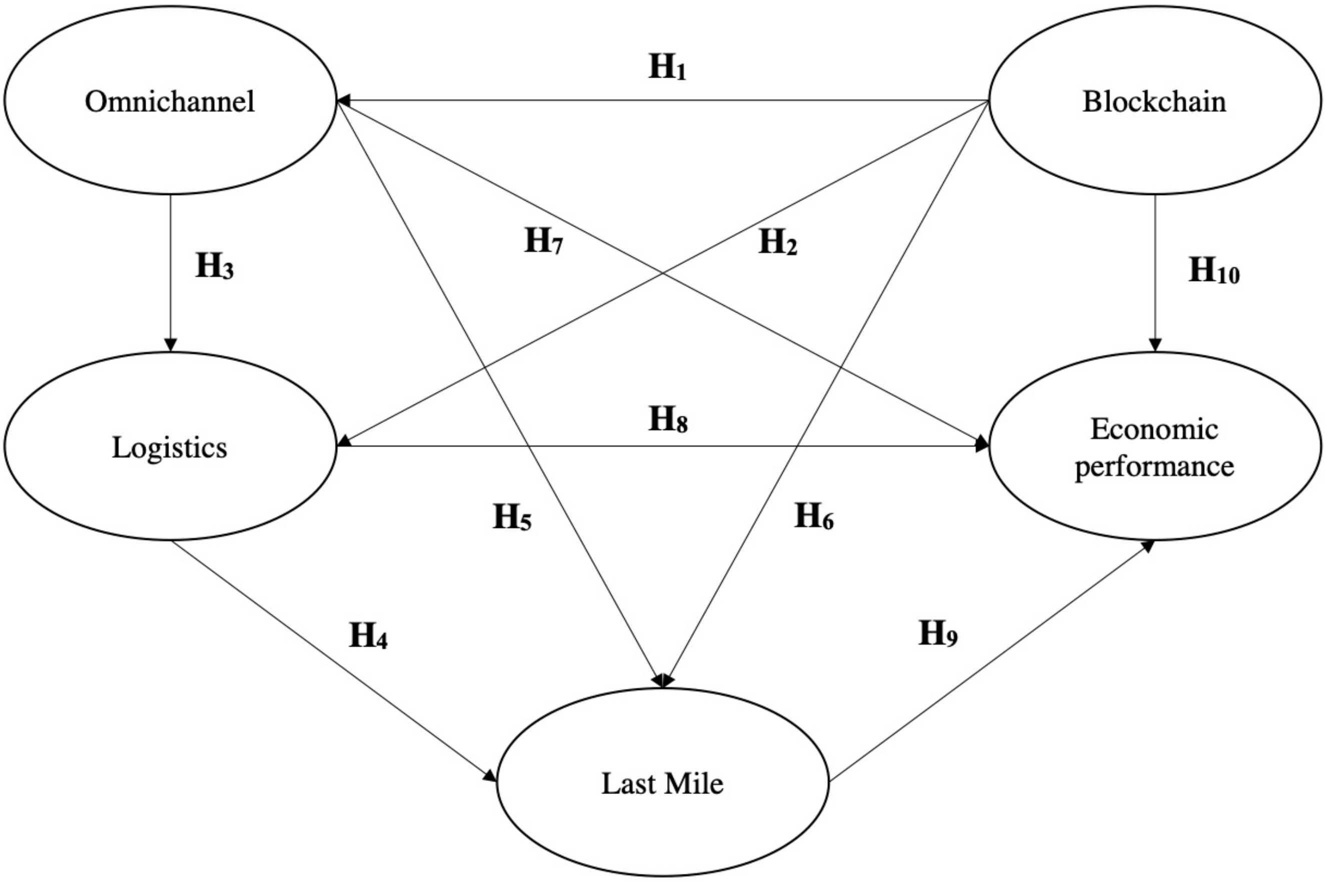

Figure 1. Conceptual model

Section 3

3. Methods

3.1 Survey design and sample description

To test our research hypotheses, we designed a survey to collect information about the respondents (e.g. industry and company type) the investments in blockchain technology, the implemented omnichannel strategies, the logistics operations, the last mile management and the economic performances (e.g. cost savings, market share, profits). The following step consisted in pre-testing the questionnaire on a pool of experts, among professors and Ph.D. students, from whom we asked for feedback about wording, readability and completeness. Consequently, the survey was modified and improved accordingly. The data collection process began by subjecting the survey to an initial sample of 120 firms' managers, a part of which was contacted before and other later. Because our research focuses on supply chain management, we chose to interview only professionals who are active in this domain. They were contacted via email and in two weeks we received the majority of the responses. In the meantime, we extended our investigation by submitting the questionnaire to an additional panel of managers. Overall, we obtained a total of 157 observations excluding those removed as invalid. The sample analyzed is mainly constituted of large enterprises both in terms of sale turnover and employees. Indeed, more than half has an average sale turnover of more than 100 million (52%) and a workforce of more than 200 employees (53%). The data collected concern prevalently European and American companies, 73% and 16% respectively. Most of the interviewees are supply chain managers (52%), working mainly for manufacturing companies (36%) and retailers (23%). The results reveal a heterogeneous industrial panorama with the Food and Beverage (22%) and the Fashion & Apparel (12%) sectors predominating. A more detailed representation of the distribution of respondents and the composition of the sample characteristics are illustrated in Table 1. Several approaches were used to assess "non-response bias." The first approach consisted of comparing early to late respondents (i.e. first and second to third surveys). A one-way analysis of variance (ANOVA) found no significant differences between early and late responses for all items. These findings support the conclusion that "non-response bias" is not a significant concern. Moreover, we checked for non-response bias by using the demographic variables size, number of employees, and average turnover. Once again, we found no significant differences between groups. All the items included in the questionnaire were measured by using a 7-point Likert scale, indicating the level of agreement with a certain question (where 1=not at all in agreement and 7=full agreement). Therefore, because the difference between the items matters and can be directly compared, we conducted the analysis at the original items' scale. In Table 2 we describe the items together with their means and standard deviations.

Sales	#	%	Employee	#	%	Country	#	%	Company	#	%	Professional	#	%	Industry	#	%
< 10	11	7.0%	< 50	14	8.9%	Europe	115	73.2%	Manufacturer	56	35.7%	SC Manager	82	52.2%	Food & Beverage	34	21.7%
10-50	38	24.2%	50-99	40	25.5%	USA	25	15.9%	Wholesaler	30	19.1%	Logistics	12	7.6%	Fashion & Apparel	18	11.5%
50-100	26	16.6%	100-200	20	12.7%	Asia	4	2.5%	Distributor	14	8.9%	Operations	13	8.3%	Medical & Healthcare	12	7.6%
> 100	82	52.2%	>200	83	52.9%	Other	13	8.3%	Supplier	21	13.4%	Sales	3	1.9%	Automobile	11	7.0%
									Retailer	36	22.9%	Production	9	5.7%	Mechanic	7	4.5%
												Purchasing	2	1.3%	Energy	7	4.5%
												Procurement	8	5.1%	Furnitures	6	3.8%
												Distribution	2	1.3%	E-commerce	5	3.2%
												Other	26	16.6%	Aerospace	4	2.5%
															Sport	4	2.5%
															Entertainment	4	2.5%
															Glass	3	1.9%
															Cement	3	1.9%
															Telecommunications	2	1.3%
															Luxury	2	1.3%
															Beauty & Cosmetics	2	1.3%
															Electical and	2	1.3%
															Chemical	1	0.6%
															Other	30	19.1%
Total	157	1		157	1		157	1		157	1		157	1		157	1

Table 1 – Sample description

Construct	Items	Question	Mean	Standard deviation
		In the last two years, our companies invested in blockchain by:		
Blockchain (B)	B1.	Consulting developers	4.924	1.573
	B2.	Modifying the management of contracts and transactions	4.393	1.523
	B3.	Tokens	4.305	1.519
	B4.	New platforms	4.796	1.623
	B5.	New training programs[a]	-	-
	B6.	Aligning the technology requirement with the regulations	4.870	1.558
	B7.	Integrating blockchain technologies with other digital technologies	4.807	1.718
		In the last two years, our company invested in the following omnichannel solutions:		
Omnichannel (O)	O1.	Buy online/pick up in–store	5.014	1.702
	O2.	Buy online/home delivery	5.352	1.681
	O3.	Buy online/delivery in other places	5.141	1.710
	O4.	Buy online/delivery in a locker	4.553	1.745
	O5.	Buy offline and take home	5.222	1.715
	O6.	Buy offline/home delivery	4.681	1.805
		In the past last years, our company has successfully managed the following logistics challenges:		
Logistics (L)	L1.	Delivery time	4.820	1.754
	L2.	Customers queries and or compliants	4.734	1.653
	L3.	Information sharing with consumers	4.721	1.774
	L4.	Post sale services	4.337	2.085
	L5.	Return management procedures	4.517	1.543
	L6.	Unattended deliveries.1[a]	-	-
	L7.	Integration of forward and reverse logistics flows	4.433	1.492
	L8.	Optimisation of the logistics network	4.974	1.523
	L9.	Optimisation of the logistics loads[a]	-	-
	L10.	Logistics risks and safety	4.810	1.556
		In the last two years, our company has managed the last mile by:		
Last Mile (LM)	LM1.	Training programs[a]	-	-
	LM2.	Changing the transportation modes	4.338	1.521
	LM3.	Unattended deliveries	3.874	1.617
	LM4.	Urban logistics systems	4.555	1.557
	LM5.	Cheap deliveries	4.396	1.646
	LM6.	Delivery cost	4.673	1.615
	LM7.	Quality of the delivered goods	4.954	1.763
	LM8.	Lack of transparency[a]	-	-
	LM9.	Reinforcing tracking system[a]	-	-

	LM10.	Investing in infromation system[a]	-	-
	LM11.	Integrating the TSL providers[a]	-	-
		In the last two years, our company has performed in terms of:		
	EP1.	Market share	4.853	1.964
Economic	EP2.	Profits	4.737	1.991
Performance	EP3.	ROI	4.814	1.797
(EP)	EP4.	Cost savings	4.664	1.791

[a] Excluded from analysis

Table 2 - Descriptive statistics of the selected items.

3.2 Methodology

To achieve the objective of this study, we used Partial Least Squares Path Modeling (PLS-PM) as the most appropriate approach for this study. PLS-PM is a component-based estimation algorithm that aims to predict the relationships between constructs and provides their scores at the original scale. Furthermore, PLS-PM does not require any distributional assumption on the data (in contrast to a maximum likelihood covariance-based approach). In fact, the items in our study are not normally distributed; thus, a maximum likelihood covariance-based approach would be inappropriate. Finally, PLS-PM provides less biased estimates than other approaches to structural equations modelling at sample sizes lower than 200 observations, while achieving the same power above 200 observations (Chin, 2010). These motivations underlie the use of PLS-PM in several business contexts, such as operations management (see, e.g., Peng & Lai, 2012), supply chain management (Colicev et al., 2016) and digital transformation (De Giovanni & Cariola, A Process innovation through Industry 4.0 technologies, Lean practices and Green Supply Chains. , 2020).

3.3 Model assessment

Measurement Model: Because in our study the constructs represent firms' traits related to their business (e.g., Economic Performance measures the firms' attitudes toward achieving a certain level of performance), we model them by means of reflective scales. To assess reflective measurement models, we must examine internal consistency, as well as convergent and discriminant validity. We followed the procedure explained in De Giovanni and Cariola (2020) to achieve these targets.

Although some items such as training programs for blockchain and last mile, lack of transparency, unattended deliveries, optimization of the logistics loads have borderline loadings with loadings between 0.5 and 0.6, the results of 5,000 resamples indicate that these loadings (and weights) are significant at 0.05 and constitute important items in terms of content validity. According to Colicev et al. (2016), these items can then be retained. Finally, we have removed all items with a loading below 0.5, specifically "L6 – Unattended deliveries". The elimination of the indicator "L6" from the construct Logistics indicates that firms still face the issue of integrating their information with consumers. During the last mile delivery, the consumers are frequently not available at the indicated address; therefore, firms should invest more in this direction to better integrate the logistics flow with the consumers' availability. Similarly, item "L9 – Optimization of logistics loads" was removed from the list of items linked to Logistics. This is probably linked to the low chance that firms have to mitigate all operative challenges imposed by the warehouse management in terms of space constraints and load optimization. Therefore, the construct Logistics will inform that firms have invested in the reduction of the delivery lead time ("L1"), which become an important lever of competitive advantage (Cui, et al., 2020). Also, Logistics is composed of a set of items linked to consumers, specifically: the consumers' service support for complaints and its integration with the logistics systems ("L2"), the information shared with consumers regarding the delivery time, invoicing, and order completeness ("L3"), as well as the prompt activation of ad hoc logistics practices to properly manage of consumers' complaints ("L4"). Furthermore, Logistics includes a set of achievements linked to the management of backward flows, specifically: the adoption of return management procedures ("L5"), which require additional efforts and atypical tasks than traditional delivery systems, the integration of forward and reverse logistics flow into one unique system (“L7”), as well as the optimization of the logistics network (“L8”) that includes all these ingredients. Finally, the logistics strategy can never disregard practice of logistics risks and safety (“L10”), which aim at preserving people’s health and society at large.

Regarding the construct Economic Performance (EP), all the items that we hypothesized being a part of this construct have good loading. In fact, it will be composed of market share (“EC1”), which indicates the firms’ performance comparatively to the competitors, profits (“EC2”), which informs on the firms’ capacity to generate economic value, ROI (“EC3”), which signals the firms’ capacity to recover the investments through the economic outcomes, and cost savings (“EC4”), highlighting the efficiency of the entire business.

The Omnichannel (O) construct will enclose the items depicting the purchase options available to customers by the company. These include the possibility of buying the product online and picking it up at the store ("O1") or receiving it at home ("O2") or anywhere else ("O3") as well as picking it up from a locker ("O4"). Also, the items “buy offline and take home” (“O5”) and “buy offline/home delivery” (“O6”) are encompassed.

The Blockchain (B) construct explores the practices that managers use to adopt this technology. The indicators relate to working with developers ("B1"), such as IBM or Hyperledger, to implement the blockchain in the enterprise environment. They also include items pertaining to the change in the standard way of managing agreements and transactions ("B2"), like the use of smart contracts, but also the developments of tokens ("B3") and even the deployment of new platforms ("B4"), resulting from the collaboration between all the SC partners. Innovations such as Blockchain require to be in line with existing regulation ("B6") not to conflict, for instance, with data protection and privacy rules, as well as to be combined with existing digital technologies to be fully exploited (“B7”). We have not mentioned the "B5 - New training programs" indicator because it has been removed from the Blockchain construct, indicating that companies are not yet investing in programs to help the employees and the stakeholders along the SC to familiarize with this new technology.

Also, from the Last Mile construct (LM) some items initially assumed to be part of this construct have been removed. In particular, the indicators "LM1 - Training program" and "LM8 - Lack of transparency" have been excluded, suggesting that companies have not yet been able to implement training programs to coordinate with the different collaborators along the SC, nor to establish a system able to guarantee the complete transparency of the Last Mile delivery. The further removal of the items "LM9-Reinforcing tracking system" and "LM10-Investing in infromation system and new high tech platforms" underlines that companies still struggle to collect and exchange product data to reduce the inefficiencies along the last mile, while the exclusion of the item "LM11-Integrating third service logistics providers" indicates that for firms it is preferable to outsource the operations of the delivery phase, likely too expensive. The remaining items include some new techniques and means to transport goods ("LM2"), symbolizing the willingness of companies to invest in improving the management of delivery processes. In addition, there are the strategies to avoid unattended delivery problems ("LM3") and to overcome problems related to urban logistics, such as traffic ("LM4"). “LM5 - Cheap deliveries", on the other hand, indicates the efforts made by managers to combine a high level of delivery quality with prices that are not too disadvantageous for both the consumer and the company. The Last Mile construct also highlights how companies strive to reduce high delivery costs ("LM6") and how they seek to ensure that the quality of the goods delivered is not impaired ("LM7"). The final items list allows to detect the cross-loadings associate to each construct, as displayed in Table 3.

	Omni	Last mile	Logistics	Econ Perf	Blockchain
Buy online/pick up in–store	**0.785**	0.215	0.267	0.220	0.382
Buy online/homedelivery	**0.867**	0.298	0.376	0.250	0.398
Buy online/delivery in other places	**0.830**	0.138	0.245	0.130	0.353
Buy online/delivery in a locker	**0.506**	0.026	-0.005	-0.098	0.329
Buy offline and take home	**0.654**	0.237	0.230	0.126	0.207
Buy offline/home delivery	**0.417**	0.034	0.015	-0.130	0.161
Changing the transportation modes	0.165	**0.506**	0.263	0.265	0.144
Unattended deliveries	0.203	**0.554**	0.351	0.280	0.120
Urban logistics systems	0.178	**0.739**	0.469	0.379	0.178
Cheap deliveries	0.204	**0.708**	0.349	0.198	0.105
Delivery cost	0.183	**0.791**	0.583	0.530	0.167
Quality of the delivered goods	0.217	**0.753**	0.619	0.626	0.193
Delivery time	0.272	0.468	**0.708**	0.500	0.236
Customers queries and or compliants	0.226	0.566	**0.727**	0.544	0.156
Information sharing with consumers	0.271	0.491	**0.746**	0.534	0.238
Post sale services	0.313	0.537	**0.793**	0.498	0.227
Return management procedures	0.304	0.528	**0.732**	0.468	0.124
Integration of forward and reverse logistics flows	0.230	0.429	**0.620**	0.283	0.239
Optimisation of the logistics network	0.155	0.387	**0.701**	0.467	0.172
Logistics risks and safety	0.157	0.391	**0.586**	0.447	0.242
Market share	0.145	0.490	0.512	**0.780**	0.200
Profits	0.141	0.353	0.532	**0.768**	0.166
ROI	0.153	0.511	0.537	**0.827**	0.187
Costs avings	0.240	0.517	0.516	**0.753**	0.158
Consulting developers	0.405	0.152	0.259	0.217	**0.819**
Modifying the management of contracts and transactions	0.394	0.171	0.198	0.175	**0.787**
Tokens	0.207	0.073	0.122	0.075	**0.668**
Newplatforms	0.355	0.269	0.242	0.271	**0.829**
Aligning the technology requirement with the regulations	0.336	0.177	0.256	0.102	**0.793**
Integrating blockchain technologies with other digital technologies	0.342	0.174	0.246	0.165	**0.810**

Table 3 – Summary of the cross-loadings

The construct reliability index assesses good internal consistency when it is higher than 0.7 (Hair et al., 2012). In our model, all constructs' reliability indexes exceed this threshold (see Table 4). Similarly, each item's reliability should be higher than 0.7 (squared loading of 0.5) so that at least half of the item variance is extracted by its respective construct (Chin, 2010). Convergent validity has been evaluated by assessing the outer loadings and using the Average Variance Extracted (AVE) criterion. As shown in Table 4, the AVE for each of our construct are all around the recommended value of 0.5 (Chin, 2010), and all of them allow us to obtain a good convergent validity.

Index of composite reliability	**Average Variance Extracted (AVE)**	**Construct**	**B**	**LM**	**O**	**L**	**EP**
0.887	0.618	*Blockchain (B)*	1.000				
0.770	0.467	*Last Mile (LM)*	0.052	1.000			
0.801	0.486	*Omnichannel (O)*	0.197	0.077	1.000		
0.853	0.496	*Logistics (L)*	0.083	0.462	0.121	1.000	
0.789	0.612	*Economic Performance (EP)*	0.052	0.364	0.048	0.449	1.000

Table 4 – Inter-construct squared correlations and reliability measures.

Finally, the discriminant validity indicates the extent to which a construct is different from others (Chin, 2010). To achieve good discriminant validity, the AVE should be higher than the squared correlation among the constructs and the item loadings within their own constructs should be higher than the loadings on the other constructs. As displayed in Tables 3 and 4 both these criteria are met in our model. Overall, we obtain good internal consistency and convergent and discriminant validity; therefore, we can proceed to evaluate the structural model, which gives a relative Good-of-fit index of 0.833.

Section 4

4. Results

4.1 Hypothesis testing

The empirical analysis of our model yields the following results, summarized in table 5. The H 1 is supported (coef. = 0.443, p-value < 0.01), highlighting that blockchain technology represents an effective technology to successfully execute and manage omnichannel strategies. In the same way, blockchain enhances the proper management of logistics processes. In fact, H 2 finds positive and significant support (coef. = 0.167, p-value < 0.05). Since also the hypothesis 3 is confirmed (coef. = 0.273, p-value < 0.01), thus investments in omnichannel are highly advantageous for the logistics system. Our results show that the Logistics is of utmost relevance to contrast and solve all obstacles that companies face during last mile phase (coef. = 0.660, p-value < 0.01). On the other hand, neither H 5, omnichannel on last mile management (coef. = 0.040, p-value > 0.1), nor H 6 blockchain on last mile (coef. = 0.019, p-value > 0.1) are supported. The last part of our research body considers the influence of our model on economic performance. H 7 is not validated (coef. = - 0.046, p-value > 0.1), underlying that there is no empirical evidence of higher economic performances when companies embrace an integrated channels approach. The same holds for the H 10 (coef. = 0.045, p-value > 0.1), whose result thwarts the connection between blockchain technology benefits and superior economic performance. In contrast, H 8 (coef. = 0.485, p-value < 0.01) and H 9 (coef. = 0.277, p-value <0.01) are both supported; therefore, investing in logistics and in last mile management, significantly increases the likelihood of performing good economic goals. Finally, we verify the existence of the indirect effects that the variables considered generate within our model. We found that investments in blockchain have an indirect positive effect on both logistics (coef. = 0.121, t-value > 2.58) and last mile (coef. = 0.208, t-value > 2.58).

Similarly, investments in omnichannel have a statistically significant effect on last mile management (coef. = 0.180, t-value > 2.58). Blockchain (coef. = 0.182, t-value > 1.96) logistics (coef. = 0.182, t-value > 2.58) and omnichannel (coef. = 0.194, t-value > 2.58) also have an indirect positive effect on economic performance.

Research Hypothesis	Direct effect	Indirect effect	Results
H_1: *Investments in blockchain have a positive impact on omnichannel management.*	0.443***		Supported
H_2: *Investments in blockchain have a positive impact on logistics management.*	0.167**		Supported
H_3: *Investments in omnichannel have a positive impact on logistics management.*	0.273***		Supported
H_4: *Investments in logistics have a positive impact on last mile delivery.*	0.660***		Supported
H_5: *Investments in omnichannel have a positive impact on last mile delivery.*	0.040		Not supported
H_6: *Investments in blockchain have a positive impact on last mile delivery.*	0.019		Not supported
H_7: *Investments in omnichannel have a positive impact on economic performance.*	-0.046		Not supported
H_8: *Investments in logistics have a positive impact on economic performance.*	0.485***		Supported
H_9: *Investments in last mile delivery have a positive impact on economic performance.*	0.277***		Supported
H_{10}: *Investments in blockchain have a positive impact on economic performance.*	0.045		Not supported
H_{2b}: *Investments in blockchain have a positive indirect effect on logistics management.*		0.121***	Supported
H_{5b}: *Investments in omnichannel have a positive indirect effect on last mile delivery*		0.180***	Supported
H_{6b}: *Investments in blockchain have a positive indirect effect on last mile delivery.*		0.208***	Supported
H_{7b}: *Investments in omnichannel have a positive indirect effect on economic performance.*		0.194***	Supported
H_{8b}: *Investments in logistics have a positive indirect effect on economic performance.*		0.182***	Supported
H_{10b}: *Investments in blockchain have a positive indirect effect on economic performance*		0.182**	Supported

***p=value<0.01; **p=value<0.05; *p=value<0.1; for indirect: ***t-value>2.58, **t-value>1.96

Table 5 – Results of the research hypotheses

Section 5

5. Discussion

5.1. Results discussion

The findings of our analysis, summarized in the previous section, give managers a clearer view of the benefits of implementing blockchain within the companies' strategies to speed up and optimize both processes and the operations along the SC. The existence of a statistically significant relationship between blockchain and omnichannel opens up new and interesting scenarios for managers. The transaction to an omnichannel approach requires a considerable effort in planning a simultaneous and homogeneous management of several channels. Achieving this result is frequently hindered especially whether companies operate in an extensive and fragmented supply chain composed by many players on multiple tiers with which they often have only an indirect bond (e.g. suppliers of suppliers). By using the blockchain system, managers can promote a reliable, verified and unalterable flow of data and information, triggering better communication and coordination between the SC parties. Therefore, blockchain enables to overcome the vision of channels as individual silos and helps companies to exploit the synergies emerging by establishing interconnections between each channel. These advantages also extend to the end-consumers. Through the blockchain, managers can monitor the journey of the product along the SC and act quickly and directly upstream, whenever problems or inefficiencies arise, preserving consumers from potential risks. The improved product traceability benefits customers who can easily obtain information about the characteristics and provenance of, for example, the raw materials of the goods they would like to purchase. Hence, the result of the blockchain's use yields an efficient and effective response to omnichannel customers' expectations. The truthfulness of our first hypothesis enriches the existing literature on the blockchain by providing more empirical evidence of its advantages on omnichannel strategies. Indeed, Hübner et al. (2016) show the effectiveness of the changeover from multichannel to omnichannel and the necessary logistical reorganization to achieve it, but without considering how the blockchain can be conducive to this goal.

Although with less intensity, our research shows that the positive impact of blockchain technology also extends to logistics strategies. The applications it finds within the logistics sector, in addition to those previously mentioned, encompass processes automation and simplification, asset monitoring, full visibility within the SC, process conformance as well as the ability to lower their monetary and timing costs (Manners-Bell & Lyon, 2019). Consequently, investing in the creation of a distributed digital ledger-based platform eliminates the frequent errors that occur in handling logistics processes (e.g. loss of documentation or loss of goods). In this sense, we can state that the dichotomy we observed in the literature between the uncertainties and opportunities of the blockchain on the logistics system is resolved in favor of its implementation. Accordingly, our analysis extends the boundaries of the literature, contrasting the unfavorable position of some scholars (e.g. Francisco et al. 2018) who are skeptical about the convenience of adopting the blockchain to improve logistical performances. Furthermore, we demonstrate how the same choice to undertake omnichannel management is an incentive for managers to rethink and redesign the entire company's logistics system. From an omnichannel perspective, it is not feasible for firms to keep on managing and operating by interacting individually with each channel. That is why managers in pursuing omnichannel strategies must necessarily improve and modify the logistics accordingly. In relation to the actual literature, which, with authors such as Brynjolfsson et al. (2013) perceives the omnichannel as the final goal of logistics strategies, this researches proposes a different perspective framing omnichannel investments as the engine of logistics processes improvement.

One of the salient points of our research is to examine the dynamics of last mile management. For managers, the latter turns out to be rather cumbersome to keep under control and extremely expensive. This is why we tested the influence of the logistics, omnichannel and blockchain variables within this area of the SC. Our findings suggest that the inefficiencies of the last mile segment are significantly mitigated by investing in the improvement of the logistics. The choice of areas in which carry out the delivery services, the flexibility in delivery times, the need to deal with urban constraints, the location of distribution centers, the requirement for suitable infrastructure, ensuring that the product is in excellent condition at the time of delivery are just a few of the countless factors that an accurate logistical strategy planning takes into account in order to best fulfil the product delivery process. Consequently, managers must foster investment and modernization of the entire logistical system to streamline, to forecast and to reduce the uncertainty of the last mile phase.

Unlike what initially assumed neither investments in omnichannel nor blockchain technology are effective drivers to overcome the negative effects of last mile. By offering alternative purchasing solutions, which combine offline or online channels with different delivery, pick up and return options does not help to reduce the number of clients choosing delivery services. This suggests that a large portion of shoppers prefer to receive the products directly at home, forcing companies to deal with the last mile issues. However, this discovery should be better contextualized considering the industry sector where the relationship between omnichannel and last mile is analyzed. For example, Bell et al (2014) has already shown that in the apparel sector the growing trend is to look for products online and then buy them offline directly in stores.

The use of the blockchain is not particularly suitable for enhancing last mile management either. This technology is not enough on its own to counteract the challenges that practitioners face during this step. Nevertheless, executives have the chance to explore the potential of blockchain by combining it with new or already existing technological means. Although still in its early stages, some companies are already following this route. The attempts to combine blockchain technology and radio frequencies (like Nike is trying to do) or robots (like in the case of Walmart and its fleet of delivery drones) are just some example. This paper contains a further contribution to the literature, which with authors such as Mangiaracina et al. (2019) although it shows to have considered several new options to handle the last mile more efficiently, it does not consider the effects of blockchain on last mile performance.

This work observes also the economic repercussions in relation to each of the variables investigated so far. Our results reveal the statistically significant relationship between logistics and economic performance. In this sense, our research reinforces and is in line with the widespread and accepted theory underpinned by literature that logistics is an essential contributor to drive companies to achieve superior economic performance. This finding highlights the importance of investing to create a logistics function as efficient and effective as possible in order to decrease the costs of operations. The validity of last mile on profitability is confirmed too. Indeed, an optimal handling of the delivery processes translates both into the opportunity of bearing lower expenses and of increased profits. Surprisingly, by carrying out omnichannel integration companies does not achieve economic gains. The evidence provided by our analysis hampers the general enthusiasm perceived by literature and indicates that the most common misconception is ignoring the complicated managerial planning behind the omnichannel. Too often managers, dazzled and tempted by the promised benefits, put in place omnichannel strategies regardless of what this entails. The vision of leveraging the short-term benefits of omnichannel is unfounded. Setting up omnichannel configuration is a long-term process that requires a meticulous processes organization. In the same way, our research denies a positive connection between the blockchain and the improved economic performance. Our conclusions are in contrast to those of some scholars, such as Ko et. al (2018) and Carter et. al (2018), who argue the economic viability of blockchain. Nevertheless, our thesis may not be validated because of the time frame in which it is located. Until now, in fact, the blockchain has not yet found such a vast and common application in SC management. Several companies are just beginning to understand its potential and to exploit it. That is why we suggest reviewing these effects in a few years, when there will be a more widespread application of blockchain.

Our analysis highlights the indirect effects of the interaction of the variables included in our model. The blockchain proves to have an indirect and positive effect both on logistics, last mile and economic performances. Practitioners who rely on this mechanism to promote the integration and communication of the channels, in order to achieve a complete omnichannel approach, should expect an indirect improvement also in the logistics system and consequently in the last mile management. This result empirically contributes to what has been said so far in the literature that with researchers like Pournader et al. (2019) theorizes only the beneficial impact of blockchain on the last mile. In the same way with blockchain companies can expect higher economic returns. Investing in blockchain improves logistics performance and consequently lowers the cost of operations and processes along the SC. This improvement in logistics also has a positive effect on last mile processes and has a further indirect and positive impact on the company's economic structure too. The same loop is generated by the decision to invest in omnichannel. Companies obtain an indirect improvement of the last mile when they invest in omnichannel because of the benefits it generates on logistics and consequently an increment in economic results.

Section 6

6. Conclusions

6.1 Conclusions

Within this paper we draw a conceptual model based on the variables blockchain, omnichannel, logistics, last mile delivery and economic performance, in order to demonstrate how the first two have a positive impact on the supply chain, improving both operational performance and economic results. The main purpose is to convince managers of the effectiveness of the blockchain and omnichannel on logistic processes, last mile challenges and economic outcomes, also trying to provide a contribution to the existing literature. The model is tested on a sample of 157 managers, employed in the logistics and supply chain divisions and coming predominantly from European companies. We estimate both direct and indirect effects by using Partial Least Squares Path Modeling algorithm (PLS-PM). The results confirm the effects of the blockchain technology on omnichannel strategies and demonstrates how both these variables encourage an effective processes and operations enhancement over the logistics system, with a particular focus on the last mile delivery. Our findings show that the blockchain turns out to be an essential component for a synergistic and combined management of business channels, but also that it can overcome several hurdles and barriers emerging in the management of logistics flows. Particularly noteworthy is its effect on last mile. Indeed, the combined actions of the implementation of such technology and omnichannel triggers a cycle that improves and makes logistics more efficient and effective, indirectly affecting the procedures and issues of the delivery process. Apart from operational performances, the economic results are rather interesting too. Investing in logistics helps to reach a better firms' processes avoiding errors and thereby incurring fewer costs. Attenuating also the impediments across the last mile translates in sustaining a significantly lower economic effort. Therefore, omnichannel and blockchain indirectly improve economic performances too. The findings of our research contribute to expanding the boundaries of the literature, providing an empirical perspective on the deployment of blockchain within the company's logistical strategies. Furthermore, managers and practitioners find in this work a useful insight on the application, effects and implications of the introduction of blockchain technology into firms' operational strategies.

6.2 Limitations and future research

This study is not free of some limitations, which are listed hereafter to inspire future researches in the same framework. Firstly, our research considers an extremely heterogeneous sample if we compare the core business of each company. A deeper analysis can focus on a particular type of company, like business to consumers ones, to better explore and understand the effects of blockchain and omnichannel. Furthermore, the data are collected in a quite limited time interval, which translates into a relatively modest number of observations. Consequently, a wider sample can increase or disconfirm the certainty and validity of our hypotheses. After that, it can be interesting to analyze how and especially if the impact of blockchain can be amplified and improved when it is combined with other cutting-edge technologies.

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Summary

1 – Introduction

Today's companies interface and interact in a dynamic market which is undergoing a radical transformation driven and punctuated by the accelerating pace at which digitalization and technological developments are advancing (Rachinger et al., 2018). Managers must be ready to understand the changes that innovations bring with them and be proactive in adopting or even anticipating them (Christensen et al., 2015). Only in this way firms can survive to the destructive wave of new trends and face competitors operating in the same sector but with totally different business models (e.g. Uber or Airbnb). In this landscape, this research focuses on what is happening to the supply chain (SC) due to the emergence of blockchain and the increasingly widespread adoption of the omnichannel approach. The purpose of this paper is twofold. On the one hand we would like to provide an empirical contribution to the existing literature and simultaneously to support the blockchain adoption creating a model within which we study, considering it as an exogenous variable, both its contribution to omnichannel strategies and how the latter and this disruptive technology can improve logistics flows along the SC, with particular attention to the last mile segment. In order to demonstrate the convenience of an optimal supply chain management, we also analyze how these variables can drive higher economic performances. This dissertation is organized as follows. In section 2 we review the literature about blockchain, omnichannel, logistics and last mile and we also present our theoretical hypotheses. In section 3 we describe the methods followed and the sample. In in section 4 the final empirical results. Section 5 is dedicated to the discussion of the managerial implications and literature contribution of our findings. In the last part, section 6, we expose the conclusions and limitations of our work.

2 – Literature Review

The companies' tendency to integrate offline channels and online channels in order to provide a seamless customer experience (Levy et al., 2013) finds its roots both in the continuous technological development (Brynjolfsson et al., 2013), the rapid changes related to consumers' purchasing habits (Yurova et al. 2016), as well as the benefits that the omnichannel offers in terms of sales growth (Ishfaq et al., 2016), brand loyalty and customer satisfaction (Chen et al., 2018). Companies operating in an omnichannel context deal with high supply chain complexity. The blockchain technology can be an effective solution to the current issues existing in omnichannel frameworks. Blockchain is defined as "a distributed digital ledger of transactions that cannot be tampered with due to the use of cryptographic methods" (Pilkington, 2016). The literature has highlighted how blockchain can enhance the economic and operational value of all the activities across the supply chains (Ksherti, 2018), improving transparency, trust and treacability among partners. However, there is still not only little knowledge of it but also confusion about its possible applications, especially in logistics (Dobrovnik et al., 2018). Literature is still exploring the dicotomy between blockchain advantages and drawbacks, questioning about whether or not the blockchain is de facto beneficial to upgrade logistics strategies. While this technology is expected to be one of the key drivers to improve the corporate logistics sector, another key driver could be omnichannel. Brynjolfsson et al. (2013) explain that this approach facilitates fulfillment processes by eliminating barriers among channel and thereby enabling communication across them and the creation of a unique set of operations, logistics and inventory. On the other hand, omnichannel strategy can be tough and challenging to apply due the high costs, the information sharing problems and because it can be very time-consuming (Larke et al., 2018; Hübner et al., 2016). Ensuring a solid logistics system can also be the cornerstone to solve the shortcomings of the last mile delivery. Lim et al. (2018) depict last mile as "the last stretch of a business-to-consumer parcel delivery service, taking place from the order penetration point to the final consignee's preferred destination point". An optimal management of the last mile process can mitigate those inefficiencies such as transportation costs, delivery costs, delays, missed deliveries and it can translate into higher economic performance and customer-related advantages (e.g. brand loyalty). Literature is attempting to answer to the necessity of making last mile delivery as efficient as possible through a reconfiguration of logistics system, involving also new solutions like crowdsourcing logistics (Wang et al., 2016) or innovative technological tools like drones (Deng et al., 2020). Among the most promising strategies to solve the last mile management problems, there can be the use of blockchain technology. Despite literature is quite silent in this regard, the examination of some practical examples (e.g. IBM Food Trust, 2018) and some scholars' researches can be considered as a starting point to foresee the future possible applications of the blockchain in the final mile delivery phase . At the same time, even if in a less tangible way, the omnichannel promises to have the potential to reduce the criticalities and the uncertainties connected to the last mile by expanding the segment of clients not choosing home delivery and therefore slimming last mile operations (Bell et al. 2014). Literature is also seeking to analyze the impact of our variables on companies' profitability. In the case of omnichannel, Bain-Altagamma (2019) and McKinsey&Company (2019) describe the changings both in consumers' attitude towards online shopping and last mile logistics strategies respectively. In this sense, scholars are studying whether omnichannel strategy can be used to exploit new trends to increase profits. Logistics and last mile delivery, instead, are usually seen by experts as critial aspects to manage to achieve higher economic results. Literature is less certain of the blockchain's implications on economic performance, but there are still too few examples to support its effectivenes. Within this context, through our research we want to contribute to the existing literature by providing empirical support on how the aforementioned elements (omnichannel, logistics, last mile, blockchain and economic performance) influence each other in order to clarify the uncertainties found along our discussion in the relationships among each variables. Accordingly, we hypothesize that:

H_1: Investments in blockchain have a positive impact on omnichannel management.

H_2: Investments in blockchain have a positive impact on logistics management.

H_3: Investments in omnichannel have a positive impact on logistics management.

H_4: Investments in logistics have a positive impact on last mile delivery.

H_5: Investments in omnichannel have a positive impact on last mile delivery.

H_6: Investments in blockchain have a positive impact on last mile delivery.

H_7: Investments in omnichannel have a positive impact on economic performance.

H_8: Investments in logistics have a positive impact on economic performance.

H_9: Investments in last mile delivery have a positive impact on economic performance.

H_{10}: Investments in blockchain have a positive impact on economic performance.

We also propose to investigate the indirect effects. Therefore, we hypothesize that:

H_{2b}: Investments in blockchain have a positive indirect effect on logistics management.

H_{5b}: Investments in omnichannel have a positive indirect effect on last mile delivery.

H_{6b}: Investments in blockchain have a positive indirect effect on last mile delivery.

H_{7b}: Investment omnichannel have a positive indirect effect on economic performance.

H_{8b}: Investments in logistics have a positive indirect effect on economic performance.

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H_{7b}: Investment omnichannel have a positive indirect effect on economic performance.

H_{8b}: Investments in logistics have a positive indirect effect on economic performance.

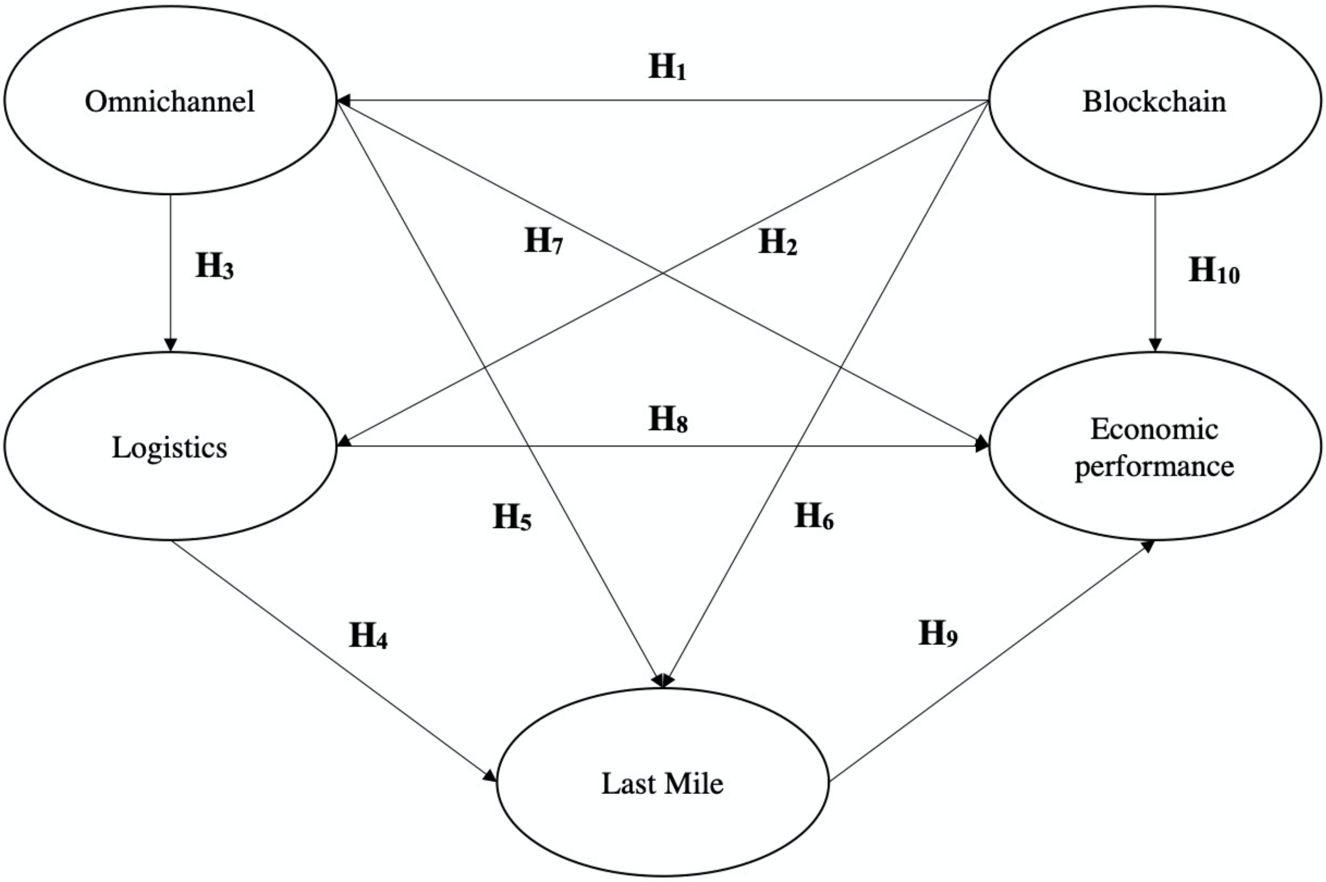

Figure 1. Conceptual model

3 – Methods

To test our research hypotheses, we designed a survey to collect information about the respondents (e.g. industry and company type) the investments in blockchain technology, the implemented omnichannel strategies, the logistics operations, the last mile management and the economic performances (e.g. cost savings, market share, profits). Overall, we obtained a final sample of 157 firms, including supply chain, logistics, operation but also distribution and sales managers, working especially for either manufacturers or retailers. The results reveal a heterogeneous industrial panorama with the Food and Beverage (22%) and the Fashion & Apparel (12%) sectors predominating. To assess "non-response bias" we used a one-way analysis of variance (ANOVA). Moreover, we checked for non-response bias by using the demographic variables size, number of employees, and average turnover. Once again, we found no significant differences between groups. All the items included in the questionnaire were measured by using a 7-point Likert scale, indicating the level of agreement with a certain question. Therefore, because the difference between the items matters and can be directly compared, we conducted the analysis at the original items' scale. To achieve the objective of this study, we used Partial Least Squares Path Modeling (PLS-PM). In fact, the items in our study are not normally distributed; thus, a maximum likelihood covariance-based approach would be inappropriate. Moreover, PLS-PM provides less biased estimates than other approaches to structural equations modelling at sample sizes lower than 200 observations, while achieving the same power above 200 observations (Chin, 2010). Because in our study the constructs represent firms' traits related to their business, we model them by means of reflective scales. To assess reflective measurement models, we must examine internal consistency, as well as convergent and discriminant validity. Although some items such as training programs for blockchain and last mile, lack of transparency, unattended deliveries, optimization of the logistics loads have borderline loadings with loadings between 0.5 and 0.6, the results of 5,000 resamples indicate that these loadings (and weights) are significant at 0.05 and constitute important items in terms of content validity. According to Colicev et al. (2016), these items can then be retained. Finally, we have removed all items with a loading below 0.5. The construct reliability index assesses good internal consistency when it is higher than 0.7 (Hair et al., 2012). In our model, all constructs' reliability indexes exceed this threshold (see Table 4). Similarly, each item's reliability should be higher than 0.7 (squared loading of 0.5) so that at least half of the item variance is extracted by its respective construct (Chin, 2010). Convergent validity has been evaluated by assessing the outer loadings and using the Average Variance Extracted (AVE) criterion. As shown in Table 4, the AVE for each of our construct are all around the recommended value of 0.5 (Chin, 2010), and all of them allow us to obtain a good convergent validity. Finally, the discriminant validity indicates the extent to which a construct is different from others (Chin, 2010). To achieve good discriminant validity, the AVE should be higher than the squared correlation among the constructs and the item loadings within their own constructs should be higher than the loadings on the other constructs. Both of these criteria are met in out model. Overall, we obtain good internal consistency and convergent and discriminant validity; therefore, we can proceed to evaluate the structural model, which gives a relative Good-of-fit index of 0.833.

4 – Results

The empirical analysis of our model yields the following results, summarized in the following table.

Research Hypothesis	**Direct effect**	**Indirect effect**	**Results**
H1: *Investments in blockchain have a positive impact on omnichannel management.*	0.443***		Supported
H2: *Investments in blockchain have a positive impact on logistics management.*	0.167**		Supported
H3: *Investments in omnichannel have a positive impact on logistics management.*	0.273***		Supported
H4: *Investments in logistics have a positive impact on last mile delivery.*	0.660***		Supported
H5: *Investments in omnichannel have a positive impact on last mile delivery.*	0.040		Not supported
H6: *Investments in blockchain have a positive impact on last mile delivery.*	0.019		Not supported
H7: *Investments in omnichannel have a positive impact on economic performance.*	-0.046		Not supported
H8: *Investments in logistics have a positive impact on economic performance.*	0.485***		Supported
H9: *Investments in last mile delivery have a positive impact on economic performance.*	0.277***		Supported

H_{10}: *Investments in blockchain have a positive impact on economic performance.*	0.045		Not supported
H_{2b}: *Investments in blockchain have a positive indirect effect on logistics management.*		0.121***	Supported
H_{5b}: *Investments in omnichannel have a positive indirect effect on last mile delivery*		0.180***	Supported
H_{6b}: *Investments in blockchain have a positive indirect effect on last mile delivery.*		0.208***	Supported
H_{7b}: *Investment omnichannel have a positive indirect effect on economic performance.*		0.194***	Supported
H_{8b}: *Investments in logistics have a positive indirect effect on economic performance.*		0.182***	Supported
H_{10b}: *Investments in blockchain have a positive indirect effect on economic performance*		0.182**	Supported

***p=value<0.01; **p=value<0.05; *p=value<0.1; for indirect: ***t-value>2.58, **t-value>1.96

Table 5 – Results of the research hypotheses

5 – Discussion

The findings of our analysis, summarized in the previous section, give managers a clearer view of the benefits of implementing blockchain within the companies' strategies to speed up and optimize both processes and the operations along the SC. The transaction to an omnichannel approach requires a considerable effort in planning a simultaneous and homogeneous management of several channels. By using the blockchain system, managers can promote a reliable, verified and unalterable flow of data and information, triggering better communication and coordination between the SC parties. Therefore, blockchain enables to overcome the vision of channels as individual silos and helps companies to exploit the synergies emerging by establishing interconnections between each channel. Although with less intensity, our research shows that the positive impact of blockchain technology also extends to logistics strategies too. In this sense, we can state that the dichotomy we observed in the literature between the uncertainties and opportunities of the blockchain on the logistics system is resolved in favor of its implementation. Accordingly, our analysis extends the boundaries of the literature, contrasting the unfavorable position of some scholars (e.g. Francisco et al. 2018) who are skeptical about the convenience of adopting the blockchain to improve logistical performances. We demonstrate how the same choice to undertake omnichannel management is an incentive for managers to rethink and redesign the entire company's logistics system. In relation to the actual literature, which, with authors such as Brynjolfsson et al. (2013) perceives the omnichannel as the final goal of logistics strategies, this researches proposes a different perspective framing omnichannel investments as the engine of logistics processes improvement. Our findings suggest that the inefficiencies of the last mile segment are significantly mitigated by investing in the improvement of the logistics. Consequently, managers must foster investment and modernization of the entire logistical system to streamline, to forecast and to reduce the uncertainty of the last mile phase. Unlike what initially assumed neither investments in omnichannel nor blockchain technology are effective drivers to overcome the negative effects of last mile. This research demonstrates the importance of investing to create a logistics function as efficient and effective as possible in order to decrease the costs of operations. The validity of last mile on profitability is confirmed too. Indeed, an optimal handling of the delivery processes translates both into the opportunity of bearing lower expenses and of increased profits. Surprisingly, by carrying out omnichannel integration companies does not achieve economic gains. In the same way, our research denies a positive connection between the blockchain and the improved economic performance. Our analysis highlights the indirect effects of the interaction of the variables included in our model. The blockchain proves to have an indirect and positive effect both on logistics, last mile and economic performances. Practitioners who rely on this mechanism to promote the integration and communication of the channels, in order to achieve a complete omnichannel approach, should expect an indirect improvement also in the logistics system and consequently in the last mile management. In the same way with blockchain companies can expect higher economic returns. Investing in blockchain improves logistics performance and consequently lowers the cost of operations and processes along the SC. This improvement in logistics also has a positive effect on last-mile processes and has a further indirect and positive impact on the company's economic structure too. The same loop is generated by the decision to invest in omnichannel. Companies obtain an indirect improvement of the last mile when they invest in omnichannel because of the benefits it generates on logistics and consequently an increment in economic results.

6 – Conclusion

This paper explores the effects of the blockchain on omnichannel strategies and demonstrates how both these variables encourage an effective processes and operations enhancement over the supply chain, with a particular focus on the last mile delivery. Our findings show that the blockchain turns out to be an essential component for a synergistic and combined management of business channels, but also that it can overcome several hurdles and barriers emerging in the management of logistics flows. Particularly noteworthy is its incidence on last mile. Indeed, the combined action of the implementation of such technology and omnichannel triggers a cycle that improves and makes logistics more efficient and effective, indirectly affecting the procedures and issues of the delivery process. Apart from operational performances, the economic results are no less interesting. Investing in logistics helps to reach a better firms' processes avoiding errors and thereby incurring fewer costs. Attenuating also the impediments across the last mile translates in sustaining a significantly lower economic effort. Therefore, omnichannel and blockchain indirectly improve economic performances too. The findings of our research contribute to expanding the boundaries of the literature, providing an empirical perspective on the deployment of blockchain within the company's logistical strategies. Furthermore, managers and practitioners find in this work a useful insight on the application, effects and implications of the introduction of blockchain technology into firms' operational strategies.

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