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Research paper

Omnichannel Management in B2B. Complexity-based model. Empirical evidence from a panel of experts based on Fuzzy Cognitive Maps

Javier Alonso-Garcia *, Federico Pablo-Martí, Estela Nunez-Barriopedro

Department of Economics and Business, University of Alcala, Plaza de la Victoria 3, 28802 Alcala de Henares (Madrid), Spain

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ABSTRACT

In recent years, academics and professionals have proposed omnichannel management as the best approach to offering multiple channels to end customers. This approach has been reinforced by the recent crisis caused by Covid-19 and the consequent demand for digital channels. In the current literature there is an evident gap in the study of omnichannel management for manufacturing or wholesale companies and their relationships with other companies, which typically use B2B models. This article includes a model that permits the identification of causal characteristics in omnichannel management based on fuzzy cognitive maps (FCM), the simulation of possible scenarios and the impact that changes in the environment or in the organization's internal activities may have on omnichannel management.

From the results of a Delphi process based on an international Panel of Experts and using complexity theory, a Fuzzy Cognitive Map (FCM) was built that can serve as a reference for B2B omnichannel management. The main value of the research is provided by the practical model that allows simulating what-if scenarios, that is, with the modification of the input conditions with respect to a base scenario and thus favors directing the omnichannel strategy to be followed in a B2B field.

1. Introduction

Omnichannel Management has been defined as *the synergetic management of the numerous available channels and customer touchpoints, in such a way that the customer experience across channels and the performance over channels is optimized"* (Verhoef, Kannan, & Inman, 2015). The omnichannel strategy aims to provide a unique and enhanced experience regardless of the purchase phase and the channel the customer is using (customer journey). This strategy has been being created since the adoption of new channels for the provision of services, mainly digital, and as this process has become generalized to practically all companies and industries. In fact, demand for an Omnichannel Management strategy is increasing, due to the recent crisis caused by Covid-19 and the necessary digitalization of manufacturing and wholesale companies that had remained faithful to their traditional channel of sales to distributors and retailers.

However, research on Omnichannel Management is very recent and has especially focused on the retail industry context. To date, it has rarely been the subject of studies in the area of relationships between companies (B2B). There are several authors who, in recent works, have pointed out the lack of research into Omnichannel in areas, such as wholesalers, that lie outside pure retail (Ilchenko, Kulik, & Magda, 2018; Kembro, Norrman, & Eriksson, 2018; Russo & Confente, 2017; Strojny & Chromińska, 2016).

The objective of this article is to establish a practical model that allows describing and simulating what actions companies with Omnichannel Management take to increase the value they create and guarantee their competitiveness.

The model to be created is subject to the scope of trade between companies (B2B). This study, therefore, focuses on manufacturers and wholesalers who reach their clients (purchasing managers) through different channels (for example, through both e-commerce and their sales force).

A practical model is pursued because it allows the researcher to simulate what-if scenarios about the context in which the company is going to develop and the impact that a change in the environment will have on Omnichannel Management. This facilitates appropriate decision-making in the omnichannel strategy to be followed in a B2B environment In other words, makes it possible to anticipate the effects on an organization—in terms of Omnichannel Management—when the

* Corresponding author at: Department of Economics and Management, University of Alcala, Plaza de la Victoria 3, 28802 Alcalá de Henares (Madrid), Spain.
E-mail addresses: franciscojavier.alon@edu.uah.es (J. Alonso-Garcia), federico.pablo@uah.es (F. Pablo-Martí), estela.nunezb@uah.es (E. Nunez-Barriopedro).

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input conditions are modified with respect to an initial base scenario.

This article is organized as follows. The first section reviews the literature, first on the B2B field, and then on Omnichannel Management in general and its relationship with B2B in particular. The next section reviews the complex theoretical model and the chosen fuzzy cognitive mapping technique. Section 3 describes the theoretical model resulting from the survey of an international panel of experts, along with the different simulation scenarios as practical examples for decision making. The results of these scenarios and the map itself are then discussed. Section 6 brings together the conclusions, with their theoretical and practical implications, as well as the limitations of the study and suggestions for future research along these lines.

2. Literature review

2.1. B2B

The study of management in the area of trade between enterprises has not been restricted to the field of e-commerce, and dates back to the late nineteenth and early twentieth centuries. However, the principal developments in the study of the theory of marketing in B2B have been made in the last four decades (Hadjikhani & LaPlaca, 2013; Vargo & Lusch, 2011). In fact, Industrial Marketing Management—one of the first journals in the field and still a key reference—was launched in 1972. Technological advances, changes in consumption habits, and the consequent digital transformation of companies, all combine to make this a trending field of study today. A search on the term B2B in SCOPUS, when restricted to the business or economic field, returns about 2000 articles. Due to the maturity of this area of research, the published studies occupy the entire value chain of an organization. For the present study, the studies that address the following matters are relevant: impact on the ROI of companies of the different marketing strategies applied (Palmatier, Gopalakrishna, & Houston, 2006); B2B branding (Leek & Christodoulides, 2011); and way traditional manufacturers are turning towards complementing their offer with services (Buratti, Parola, & Satta, 2018; Nezami, Worm, & Palmatier, 2018). However, several of the authors cited here emphasize that there is still a significant gap in the study of marketing in the context of B2B when compared with the abundant literature on B2C and the retail channel. In general numbers, this is clearly a failing, because, according to United Nations estimates, the market for business-to-business (B2B) electronic commerce is $ 21 trillion, which is equivalent to 83% of global electronic commerce (UNCTAD, 2020).

2.2. Omnichannel

The omnichannel concept initially appears in generalist articles (Brynjolfsson, Hu, & Rhaman, 2013; Rigby, 2011) that confirmed that this was a new trend in companies resulting from the adoption of new technologies. Scientific studies to date have been working on different aspects of companies' multichannel strategies and even the "cross-channel" impact between channels (Avery, Steenburgh, Deighton, & Caravella, 2013; Konuş, Neslin, & Verhoef, 2014; Neslin et al., 2006). It should be taken into account that the new digital channels already required a change in strategy and corporate skills (Leeflang, Verhoef, Dahlström, & Freundt, 2014). Scientific studies of the omnichannel strategy itself began with articles that were limited to the retail field (Gallino & Moreno, 2014; Piotrowicz & Cuthbertson, 2014), one of which is the source of the formal definition of Omnichannel Management included in the introduction (Verhoef et al., 2015). Thus, there have been important articles that explore the impacts of Omnichannel Management on five main areas in B2C commerce: the characterization of the omnichannel customer, their behavior and expectations (CU in Table 1); the inclusion of new channels and their differentiated strategy (CH); the impact on logistics and derived models (LO); the application of technologies in the omnichannel B2B field (IT) and finally, the

Table 1
Literature review.

Scope	Field	Year	Authors	Article	Journal
CU	Retail	2016	Chou, S., Shen, G. C., Chiu, H., & Chou, Y.	Multichannel service providers' strategy: Understanding customers' switching and free-riding behavior	Journal of Business Research
CU	Retail	2016	Lemon, K. N., & Verhoef, P. C.	Understanding Customer Experience Throughout the Customer Journey	Journal of Marketing
CU	B2B	2016	Pawłowski, M., & Pastuszak, Z.	B2B Customers Buying Behavior	International Journal of Synergy and Research
CH	Retail	2015	Beck, N., & Rygl, D.	Categorization of multiple channel retailing in Multi-, Cross-, and Omni-Channel Retailing for retailers and retailing.	Journal of Retailing and Consumer Services
CH	Retail	2015	Cao, L., & Li, L.	The Impact of Cross-Channel Integration on Retailers' Sales Growth	Journal of Retailing
CH	Retail	2015	Herhausen, D., Binder, J., & Schoegel, M.	Integrating Bricks with Clicks: Retailer-Level and Channel-Level Outcomes of Online – Offline Channel Integration.	Journal of Retailing
CH	Retail	2015	Pauwels, K., & Neslin, S. A.	Building With Bricks and Mortar: The Revenue Impact of Opening Physical Stores in a Multichannel Environment.	Journal of Retailing
CH	Retail	2017	Gao, F., & Su, X.	Omnichannel Retail Operations with Buy-Online-and-Pick-up-in-Store	Management Science
CH	Retail	2018	Zhang, J., Xu, Q., & He, Y.	Omnichannel retail operations with consumer returns and order cancellation.	Transportation Research Part E: Logistics and Transportation Review
CH	B2B	2018	Kim, J. C., & Chun, S. H.	Cannibalization and competition effects on a manufacturer's retail channel strategies: Implications on an omni-channel business model	Decision Support Systems
CH	B2B	2019	Modak, N. M., & Kelle, P.	Managing a dual-channel supply chain under price and	European Journal of Operational Research

(continued on next page)

Table 1 (*continued*)

Scope	Field	Year	Authors	Article	Journal
				delivery-time dependent stochastic demand.	
LO	Retail	2016	Bernon, M., Cullen, J., & Gorst, J.	Online retail returns management: Integration within an omni-channel distribution context	International Journal of Physical Distribution & Logistics Management
LO	Retail	2016	Hübner, A., Kuhn, H., & Wollenburg, J.	Last mile fulfilment and distribution in omni-channel grocery retailing: A strategic planning framework.	International Journal of Retail and Distribution Management
LO	Retail	2016	Ishfaq, R., Defee, C. C., & Gibson, B. J.	Realignment of the physical distribution process in omni-channel fulfillment	International Journal of Physical Distribution & Logistics Management
LO	Retail	2018	Castillo, V. E., Bell, J., Rose, W., & Rodrigues, A.	Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions	International Journal of Production Economics
LO	Retail	2018	Galipoglu, E., Kotzab, H., Teller, C., Yumurtaci Hüseyinoglu, I. Ö., & Pöppelbuß, J.	Omni-channel retailing research – state of the art and intellectual foundation.	International Journal of Physical Distribution and Logistics Management
LO	Retail	2018	Kembro, J. H., Norrman, A., & Eriksson, E.	Adapting warehouse operations and design to omni-channel logistics	International Journal of Physical Distribution & Logistics Management
LO	Retail	2018	Lim, S. F. W. T., & Srai, J. S.	Examining the anatomy of last-mile distribution in e-commerce omnichannel retailing: A supply network configuration approach	International Journal of Operations and Production Management
LO	Retail	2018	Melacini, M., Perotti, S., Rasini, M., & Tappia, E.	E-fulfilment and distribution in omni-channel retailing: a systematic literature review.	International Journal of Physical Distribution & Logistics Management
LO	Retail	2018	Wollenburg, J., Hübner, A., Kuhn, H., & Trautrims, A.	From bricks-and-mortar to bricks-and-clicks: Logistics networks in omni-channel grocery retailing.	International Journal of Physical Distribution and Logistics Management
LO	B2B	2018	Marchet, G., Melacini, M., Perotti, S., Rasini, M., & Tappia, E.	Business logistics models in omni-channel: a classification framework and empirical analysis.	International Journal of Physical Distribution & Logistics Management
LO	B2B	2019	Wieczerniak, S., & Milczarek, J.	Concept for identifying problems in supply chains in omni-channel systems.	Logforum
IT	Retail	2014	Piotrowicz, W., & Cuthbertson, R.	Introduction to the Special Issue Information Technology in Retail: Toward Omnichannel Retailing	International Journal of Electronic Commerce
IT	Retail	2017	Saghiri, S., Wilding, R., Mena, C., & Bourlakis, M.	Toward a three-dimensional framework for omni-channel	Journal of Business Research
IT	B2B	2017	Aichner, T., & Gruber, B.	Managing customer touchpoints and customer satisfaction in B2B mass customization: A case study	International Journal of Industrial Engineering and Management
MG	Retail	2015	Hansen, R., & Sia, S. K.	Hummel's Digital Transformation Toward Omnichannel Retailing: Key Lessons Learned.	MIS Quarterly Executive
MG	Retail	2017	Ailawadi, K. L., & Farris, P. W.	Managing Multi- and Omni-Channel Distribution: Metrics and Research Directions	Journal of Retailing
MG	B2B	2016	Lapoule, P., & Colla, E.	The multi-channel impact on the sales forces management.	International Journal of Retail and Distribution Management

omnichannel corporate management strategy in general (MG). Table 1 shows the main articles published in each of these fields of study.

2.3. Omnichannel in the field of B2B

Before the omnichannel concept was developed, there had been various studies on the impact that the use of new channels and a multichannel strategy can have in the B2B field (Chung, Chatterjee, & Sengupta, 2012), as well as the application of disruptive technologies in the B2B field (Obal & Lancioni, 2013). The first article on omnichannel strategy already predicted its impact on manufacturers, including the fact that they would be forced to produce differently (Brynjolfsson et al., 2013). As mentioned above, papers on omnichannel have mainly focused on the retail field. However, companies that occupy a position higher up in the supply chain, such as manufacturers, distributors and wholesalers, i.e. those that typically carry out these B2B transactions, are equally affected by the changes in consumption habits of buyers (in their case, the industrial/ professional buyer). Such companies have also been impacted by the obligatory adoption of digital channels. Even with the low number of articles, several lines of study have already been started (Alonso-Garcia, Pablo-Martí, & Nunez-Barriopedro, 2021). Based on the five areas described in the previous section that characterize omnichannel research lines in general, the relevant articles that are applicable in the B2B field have also been included in Table 1. The characterization of the client therefore refers to the professional client.

Studies on channel strategy are particularly relevant to studies on price policies. And finally, corporate management especially reflects the impact on the sales force of the industrial customer's behavior.

3. Theory & method

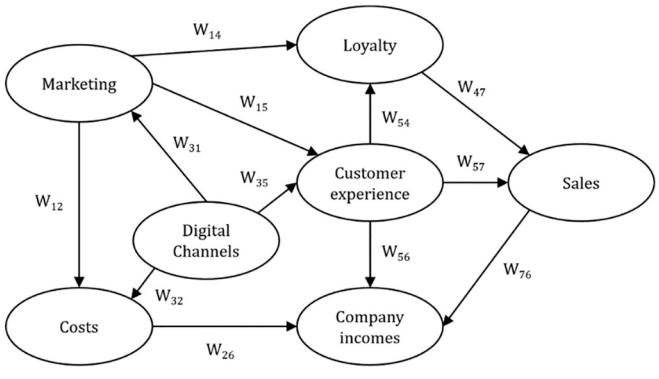
In order to build a model that brings together the interactions of an omnichannel scenario, and in which it is consequently possible to identify and measure which causal elements are the most important, this study has been based on Complexity Theory. The Fuzzy Cognitive Map (FCM) technique was chosen for modeling. *"Fuzzy Cognitive Maps are a methodology for modeling method in the decision-making process of complex systems"* (Kalantari & Khoshalhan, 2018). FCM is a modeling technique that allows the properties of the variable (Omnichannel Management, in this case) to be modeled from expert knowledge (see Figure 1). The FCMs "*define the causal links between events"* and show "*how variables relate to one another and cause changes"* (Dickerson & Kosko, 1994). Organizations often face an "*unstructured decision making problem due to the large number of variables to consider and the uncertainty imposed on those variables"* (Lee, Lee, Lee, & Lim, 2013). Thus, firstly, a solid theoretical framework is required that permits the identification of those variables or factors that are decisive in the company-client relationship in the omnichannel field. And secondly, it is also necessary to provide tools that show how this complex network operates. This will make it possible to analyze possible intervention scenarios, based on the nodes and interactions that characterize the organization (Xirogiannis & Glykas, 2004).

The aim was therefore to build the map of customer-company relationships (network) within the scope of B2B Omnichannel Management by using a Fuzzy Cognitive Map. This process consisted of three phases:

1. Nodes: Key Concepts from an Expert Panel.
2. Map: Cause-and-effect relationship in each of the arcs and a graphical representation of the network
3. Model: Numerical values and computational simulation

Once the Omnichannel Management model had been formulated, the subsequent simulation tasks (what-if scenarios) were carried out, with assumptions that modify the input variables (Value Repositories and Constraints), to finally check what impact these changes have on the performance of Omnichannel Management.

The panel was selected from managers of manufacturing or wholesale companies that had already initiated an omnichannel strategy. Once



$$a_i^{t+1} = f\left(\sum_{j=1, j\neq 1}^{n} w_{ji} a_j^t\right)$$

Fig. 1. Example FCM to calculate concept values.

the companies had been chosen, C-level employees were contacted. In preparing the panel, over 1000 top-level managers were contacted worldwide. The first round of the Delphi survey was sent to 455 managers, of whom 83 (18.2%) agreed to participate.

Regarding the size of the Delphi sample, in this field of study, articles have been published based on an Expert Panel of as few as 18 members (von Briel, 2018). This aspect has been extensively discussed in the literature. It can be concluded that the optimal size is between 15 and 30 experts having similar training and a general understanding of the field of interest (Akins, Tolson, & Cole, 2005). Thus, the panel was finally limited to 30 experts (6.6% of the total), while ensuring that all panelists worked for different companies and representing the largest possible number of countries. This expert panel was made up of executives from manufacturers and wholesalers in 17 countries spread over five continents: Argentina, Australia, Belgium, Brazil, Czech Republic, Denmark, Estonia, Germany, India, Italy, Mexico, Spain, Switzerland, Thailand, Tunisia, UK and USA (see(see Figure 2).

The Delphi was structured in four rounds in the period from October 2019 to February 2020. The first round was completed in the weeks of October 7 and 14, 2019. The second round was held in November 2019. The third round began in December 2019 but ended in January 2020. The final round ended in February 2020. The average time it took for panelists to complete the entire survey in each round was 6 m:56 s, 10 m:2 s, 37 m:14 s and 28 m:36 s respectively. As described later in the next section, the last two rounds were somewhat complex and required more attention, but the average times reveal the attention the panelists devoted to the project (see Figure 3).

The objective of this study is twofold:

1. To answer the question: What actions should companies with Omnichannel Management take to increase the value they create and guarantee their competitiveness?
2. To simulate the set of changes that will improve value creation in companies with Omnichannel Management and allow executives to expect profits.

4. Results of the study. Delphi process, final model and simulation scenarios

4.1. Delphi process

For the first round of the Delphi process, an online questionnaire with two unique questions was designed. The questions are designed to generate an "expert consensus" on the external constraints on the creation of value in omnichannel organizations, and also a consensus on the key value repositories that affect the performance of Omnichannel Management.

After completing Round 1, a second questionnaire (Round 2) was submitted in which the experts were asked to review the elements summarized by the research team based on the information provided in the first round. In this second round, a consensus was established as to the basic components of value creation in omnichannel companies.

On the one hand, the main external constraints on value creation in Omnichannel Management were identified. This yielded a list of ten constraints. Understanding that the term "value" may be subjective, the responders were requested to consider "value" in general terms, either as the client's user value, the value exchanged with the client, the value offered to the market or a combination of these.

Additionally, key value repositories in omnichannel companies were identified. Based on their best knowledge and experience, the responders were requested to state what they believe to be the key value repositories that impact Omnichannel Management in the long term. Each of these experts was asked to identify up to 15 repositories, taking into consideration all the functions of a company. The term value repositories referred to autonomous internal operating networks that group together activities, resources, processes and/or multifunctional

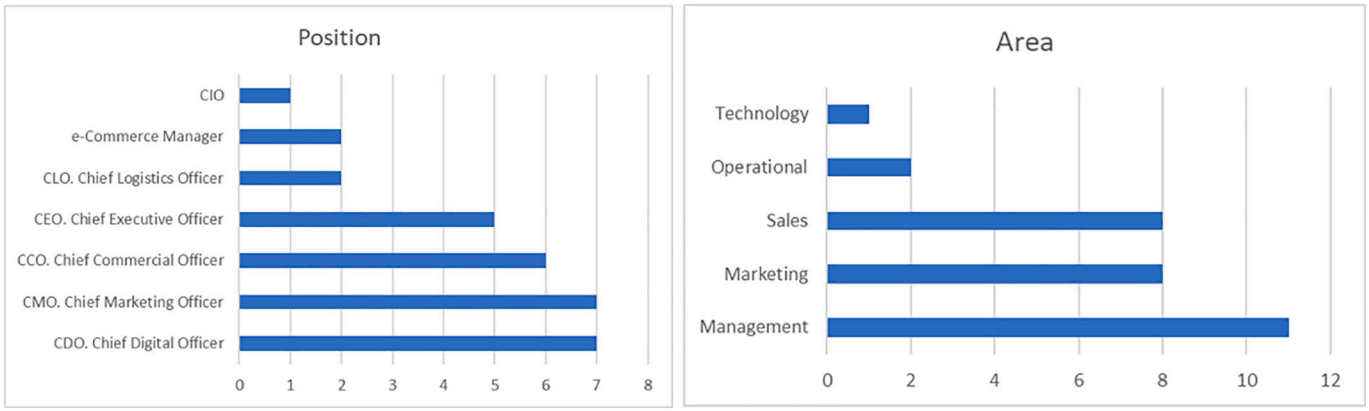


Fig. 2. Panelists by role and area.

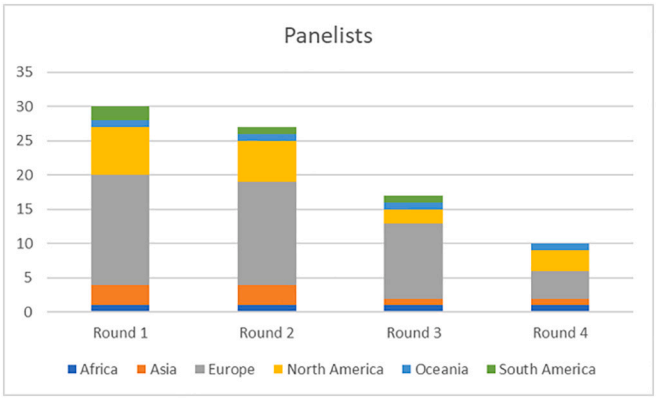


Fig. 3. Delphi panelist distribution for each round.

tools, with the sole purpose of creating a unique and differentiated value to be exchanged with other internal or external repositories. The expert responders were warned that, in most cases, the repositories do not coincide with specific units in the organization chart, nor with the dimensions of the conventional value chain.

After completing Round 2, an interim report summarizing the results obtained in Rounds 1 and 2 was submitted. This was then followed by a third questionnaire (Round 3) in which the experts were asked to establish the relationships and impact weights between the consensus value constraints, the consensus value repositories and the performance of Omnichannel Management in an organization. After the first two rounds, the 10 constraints on which the experts agreed are as listed in Table 2 lists (brackets have been placed around the labels to make the charts easier to read later):

Likewise, the 15 value repositories on which there was a consensus are those listed in Table 3:

Based on the value repositories, four specific scopes can be grouped. Firstly, those that are intrinsic to the Customer: shopping experience and loyalty. Secondly, those with a technical/technological component: IT Management and Channel Integration. A third block is made up of traditional marketing aspects, such as the Brand, Value Proposition, Portfolio and Digital Channels enabled; to which is added the 360 vision of the client for the analysis of behavior. Lastly, the most general area, which is linked to corporate management, from the company's own culture and corporate leadership, to innovation, through sales, marketing and distribution network management.

The questionnaire consisted of 3 questions divided into the following sections. The first collected how each of the 10 agreed value constraints impacted on the 15 agreed value repositories. Similarly, the second section collected the impact that each value repository had on the rest of the agreed value repositories. Finally, the respondents were asked how the 15 consensus value repositories affect long-term Omnichannel Management (OM, as a label in the charts) in their companies.

In the last round, based on the results chosen in the previous round, the experts were requested to indicate the "Sign of the link" (i.e. whether the link or interconnection is positive or negative) for these three cases: the link between Constraints and Value Repositories, Value Repositories' links to each other and the link between Value Repositories and Omnichannel Management. They were informed that a positive link is a relationship between two factors such that, as one factor increases, the other also increases. A negative link is a relationship such that, as one factor increases, the other decreases. And a neutral sign refers to a link that does not exist.

Table 2
Constraints on which the experts agreed.

Constraint	Charts labels
Achieve an internal **agreement** on value (as a priority objective with omnichannel management)	(AG)
Maturity of the channel	(MT)
The customer **approach**	(AP)
Knowledge of the customer or supplier (data, single view)	(KN)
Difficulty finding resources with appropriate skills (**Human Resources**)	(HR)
Funds / **Finance**	(FI)
Integration of new **technology** with existing solutions in the company (backoffice)	(TE)
Proliferation of **stakeholders** involved in the company itself.	(ST)
The **cost** of adopting the new technology internally.	(CO)
The **transformation** of the process and the traditional way of selling.	(TR)

Table 3
Value repositories with a consensus.

Constraint	Charts labels
Analysis of Customer Data (**360 vision**)	(VI)
Brand (s)	(BR)
Channel **Integration**	(IN)
Corporate **Culture**	(CU)
Customer **Experience**	(EX)
Customer **Loyalty**	(LO)
Customer-centric **proposition**	(PR)
Digital **channels**	(CH)
Innovation	(IV)
IT Management	(IT)
Management Leadership	(MG)
Marketing Management	(MK)
Network (suppliers and distributors)	(NT)
Portfolio of Products and Services	(PF)
Sales Management	(SA)

We then used the following Figure 4 to show the impact between the variables agreed upon by the panel of experts.

Visually, it can be seen that there is no homogeneity in the impacts that the model variables have on each other. Some constraints, such as difficulty finding resources with the appropriate skills, financial needs, or in-depth knowledge of the customer or supplier, which were chosen in previous rounds, now have a weak impact on most value repositories, except for certain value repositories, i.e. the Customer-centric proposition, Innovation, and customer data (360 view), for which the strength of the interconnect is labeled primarily as above average. However, some constraints have a "strong" impact, such as the transformation of the process and the traditional way of selling, the cost of adopting new technologies, and the approach to the customer. At the same time, the proliferation of actors in the company and the difficulty in achieving an internal agreement on value (corporate goals) are the constraints with the weakest interconnections of all.

Two value repositories that were significantly impacted ("strong" impact) by the constraints can be highlighted: channel integration and customer-centric proposition. At the other end, the distribution network (suppliers and distributors) is the value repository least impacted by the constraints.

The most frequently labeled interconnection strengths between the value repositories are summarized in the heatmap diagram presented in Fig. 5. Visual observation of the graph suggests a degree of dispersion similar to that of the constraints. The weakness of the interconnections in the relationship network (suppliers and distributors) is particularly noteworthy, although the interconnections with IT management and the brand itself are also weak. On the other hand, customer experience and the customer-centric proposition are the ones that are most strongly impacted.

Fig. 6 reveals, based on Panel Members' responses, that value repositories mainly have a strong impact on Omnichannel Management.

The main interconnections are due to Customer Data Analysis (360 view), Channel Integration and Digital Channels, not to mention the "Strong" interconnection assigned to Experience and the Customer-centric proposition, to name just a few examples.

4.2. *Complexity analysis*

The FCM-based map was constructed from the information collected in Delphi. This map should represent the company system and thus display the complexity of the company network.

The graph was analyzed using hierarchical grouping (Figs. 7, 8 and 9). The hierarchical grouping algorithm groups similar objects into groups called clusters. The result is a hierarchy of clusters, in which each cluster is distinct from the others and the value repositories within each cluster are very similar to each other (Cunningham, 1972).

However, to simplify the display of clusters, the following figure includes the groups for which the strength of the interconnections is "Strong" or "Very strong":

The clusters that were collected are the following:

- Cluster 1 (red) contains seven (7) value repositories: the Brand, the Customer Experience, Customer Loyalty (Loyalty), the Customer-Centric Proposition, Marketing Management, the Portfolio of Products and Services and Sales Management.
- Cluster 2 (yellow) contains four (4) value repositories: Channel Integration, Digital Channels, Innovation and IT Management.
- Cluster 3 (green) contains two value repositories: Corporate Culture and Management Leadership.
- Cluster 4 (blue) is made up of a single value repository: Analysis of Customer Data (360 vision)
- Cluster 5 (purple) is also made up of a single value repository: Network (suppliers and distributors) (NT)

The Appendix entitled "R code for Network Analysis" presents a summary of some of the key topological methods available for understanding network complexity. For several decades, tools for social network analysis were essentially isolated from those supporting conventional statistical analyses. A major reason for this isolation was the difficulty in manipulating and representing relational data within standard statistical packages (Butts, 2008). In recent years, the emergence of flexible statistical computing environments allows the world of network data to become more accessible, and analyzing such complex datasets becomes more feasible for "*a range of scientists to dive straight into network analysis*" (Kolaczyk & Csárdi, 2014). The complexity

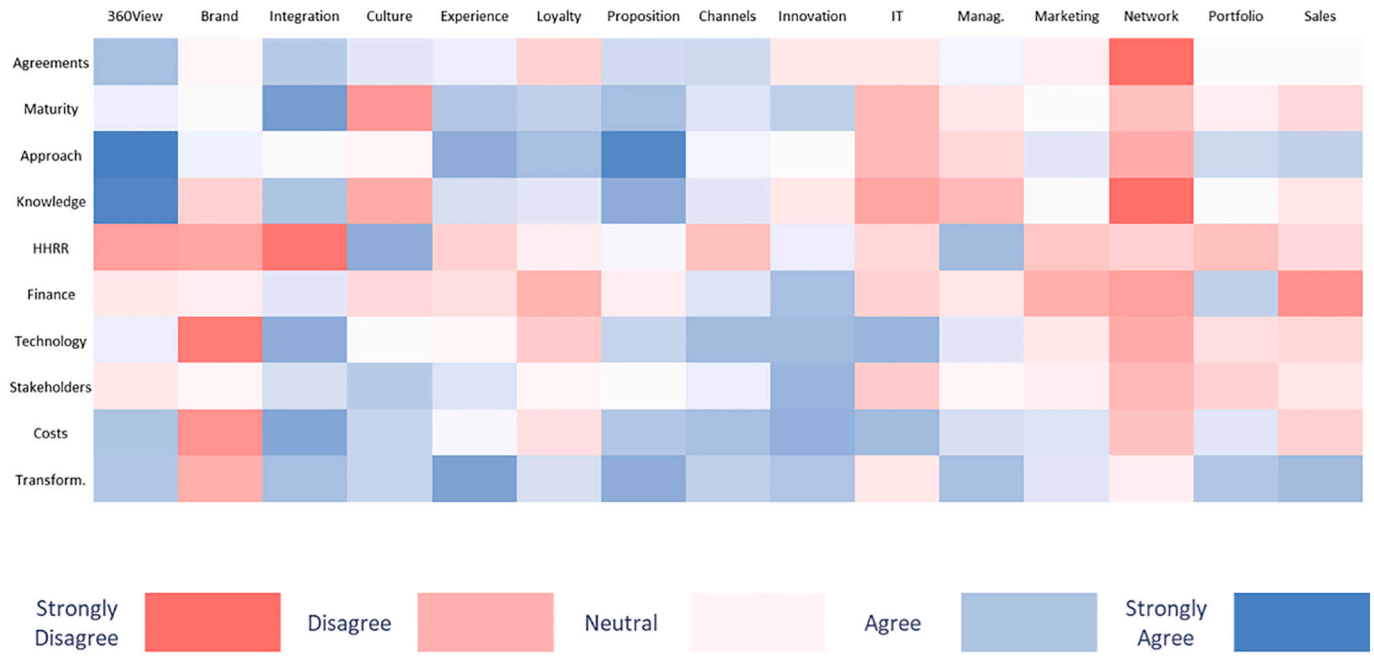


Fig. 4. Interconnection strength, constraints - value rep.

Fig. 5. Interconnection strength, value rep to each other.

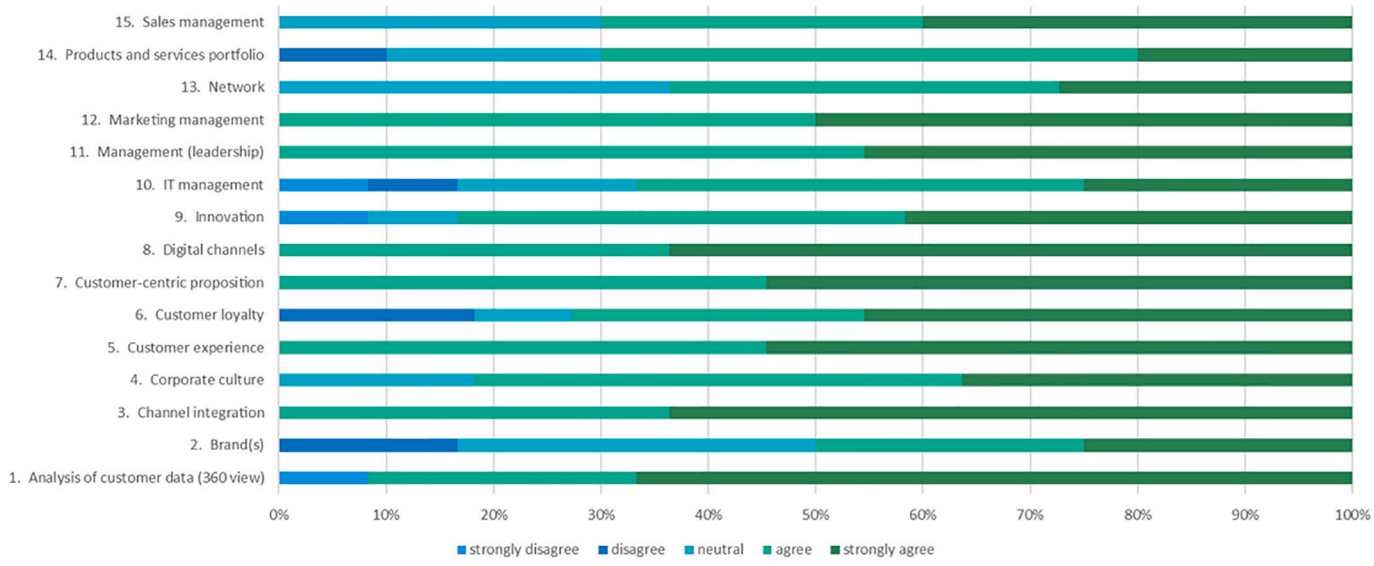


Fig. 6. Interconnection strength. OM-value reps.

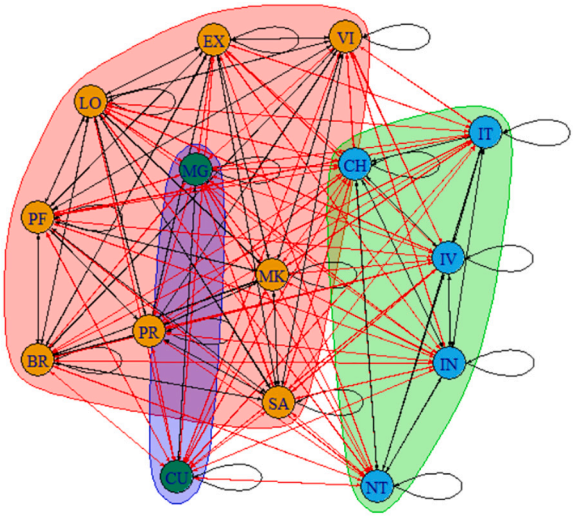


Fig. 7. Hierarchical grouping for all data gathered.

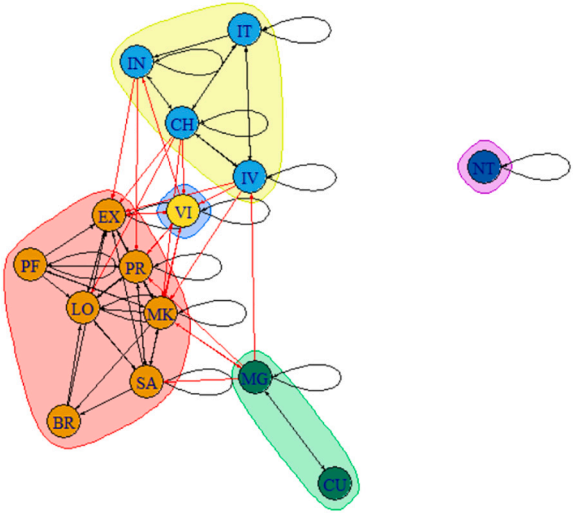


Fig. 8. Hierarchical grouping based only on strong links.

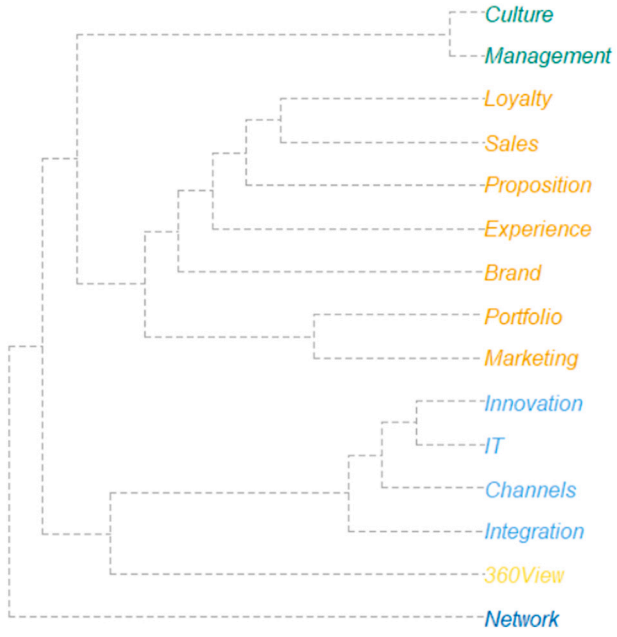


Fig. 9. Dendrogram for strong interconnections.

methods of the topological network presented in the annex include vertex characteristics, measures of network cohesion and assortativity.

Eigenvalue/Eigenvector decomposition is commonly used to reduce the dimensionality of a high-dimensional space while its internal structure is preserved. Given a collection of value repositories in a high-dimensional space, "*the eigenvalues of the covariance matrix reveal the underlying dimensionality of the space*" (Börner, Chen, & Boyack, 2005). Each node within the network will be given a score or value: the higher the score the greater the level of influence within the network. Thus, the more central the neighbors of a value repository are, the more central that value repository becomes (Kolaczyk & Csárdi, 2014).

Table 4 lists the eigenvector centrality values. Given these results, Customer Experience is the most influential value repository in the network model. Based on giving the maximum value to this repository, the values of the others have been calculated.

It is worth noting that value repositories related to the sales strategy—e.g. Value proposition, marketing and sales—are the most important value repositories, while the Network is the least relevant repository within the model.

So far, fifteen value repositories have been identified that affect the Omnichannel Management of companies. Given that all value repositories, according to Delphi, have an impact on the Omnichannel Management of a company, the intensity and influence of each one with such management must be studied. Thus, twelve value repositories have a "very strong" interconnection with Omnichannel Management, specifically all except the Brand, IT Management, and the Network.

Table 4
Value repositories in order of importance in the model (own elaboration).

Value Repository	Weight
Experience	100
Proposition	98
Marketing	96
360View	94
Sales	94
Loyalty	94
Innovation	92
Channels	91
Management	90
Integration	90
Culture	84
Portfolio	82
Brand	82
IT	81
Network	72

4.3. B2B Omnichannel model

Fuzzy Cognitive Map (FCM) "*is a soft computing technique useful to model the dynamics involved in a given complex system using a set of concepts and the causal relationships between them*" (De Maio et al., 2015). "*FCM uses a mix of qualitative and quantitative approaches, it enables the inclusion of multiple and diverse sources to overcome the limitations of expert opinions, it considers multivariate interactions that lead to nonlinearities, and it aims to make implicit assumptions (or mental models) explicit*" (A. J. Jetter & Kok, 2014). This technique is increasingly used in the field of social sciences, including marketing and business management (Xirogiannis & Glykas, 2004). Of special interest to the scope of this study are articles on industrial marketing planning (Lee et al., 2013) and studies on industrial logistics (Kalantari & Khoshalhan, 2018; Mirghafoori, Morovati Sharifabadi, & Karimi Takalo, 2018).

FCM is used to make a causal representation of business maturity principles, from which it is possible to simulate the operational efficiency of complex strategy models with imprecise relationships and quantify the impact of strategic change on the business model (Xirogiannis & Glykas, 2007). This is the final objective of the study, i.e. to make a causal representation of the elements that affect the Omnichannel Management of a company in the B2B field, from which simulations can be carried out to infer the impact.

"*FCM model building is a multi-step process that captures causal knowledge in the form of cognitive maps, formally describes these maps as adjacency matrices, and applies neural network computation to refine the model and analyze model results*" (A. J. Jetter & Kok, 2014). According to this multi-step process, the Delphi described above was performed to cover the first stage of the process, namely, knowledge capture. Subsequently, the FCM model was built on the adjacency matrix obtained from the causal cognitive map described by the Delphi results. Finally, simulation scenarios have been chosen from different input vectors in order to interpret the effects that modifying the model variables have on Omnichannel Management.

The results of the survey of the panel of experts have been adjusted to a five-point Likert scale (von der Gracht, 2012). Greater value in these results means a greater impact on the relationship between the measured variables: constraints, value repositories and Omnichannel Management. To generate a unique cognitive map, an adjacency matrix has been constructed that collects the average value (weight) of the individual values given by each panelist.

The signs, ranging from positive (+1) to negative (−1), which describe the causal relationships between network components, are also incorporated into the adjacency matrix. When the weight ω_{ij} is positive, it implies a positive causality between the two components of the relationship C_i and C_j. If the weight is negative, an increase in C_i implies a reduction in C_j. If the weight is zero, there is no effect between those two components.

The adjacency matrix calculated for the model is shown in the Table 5 below.

In the last stage of the process, the model that has been built is initialized. FCM simulations can be used to experiment with different decision alternatives and compare their outcomes holistically, i.e. with regard to all variables of interest. Thus, "*complex decision problems can be dealt with*" (A. Jetter, 2006). For demonstration purposes, this research has randomly taken an input vector to initialize the model and provide a baseline against which to compare the results of new scenarios that modify the input variables. "*The value of each concept is calculated, computing the influence of other concepts to the specific concept, by applying the calculation rule of equation*" (Stylios & Groumpos, 1999):

Table 5
Adjacency matrix.

	AG	MT	AP	KM	HR	FI	TE	ST	CO	TR	VI	BE	IN	CU	EX	LO	PR	CH	IV	IT	MG	MK	NT	PF	SA	OM
AG	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7500	0,5167	0,7000	0,6000	0,5833	0,4333	0,6429	0,6500	0,4833	0,4833	0,5667	0,5000	−0,1786	0,5333	0,5333	0,0000
MT	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,5833	0,5333	0,8750	0,2833	0,7167	0,6833	0,7500	0,6167	0,6833	0,3667	0,4833	0,5333	0,3833	0,5000	0,4500	0,0000
AP	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,9667	0,5714	0,5357	0,5179	0,8167	0,7500	0,9464	0,5667	0,5357	0,3667	0,4464	0,6000	0,3333	0,6500	0,6786	0,0000
KM	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,9500	0,4333	−0,7333	0,3333	0,6333	0,6000	0,8167	0,6000	0,4821	0,3167	0,3667	0,5333	−0,1833	0,5333	0,4833	0,0000
HR	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	−0,3000	−0,3167	−0,2000	0,8167	−0,4333	−0,5000	−0,5500	−0,3833	0,5833	0,4464	0,7667	0,4000	−0,4286	−0,3833	−0,4500	0,0000
FI	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	−0,4833	−0,5000	−0,6000	−0,4500	−0,4667	−0,3500	−0,5000	−0,6167	−0,7500	−0,4333	−0,4833	−0,3393	−0,3000	−0,6833	0,2667	0,0000
TE	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	−0,5833	−0,2167	0,8167	0,5333	−0,5167	−0,4167	−0,6667	0,7667	0,7667	0,7857	0,6000	0,4833	0,3333	0,4643	0,4464	0,0000
ST	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	−0,4833	−0,5167	−0,6333	−0,7000	−0,6167	−0,5167	-0,5333	-0,5833	-0,7833	0,4167	0,5167	0,5000	0,3667	-0,4333	-0,4833	0,0000
CO	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	-0,7333	0,2679	-0,8393	0,6667	-0,5536	-0,4643	-0,7167	-0,7500	0,8036	0,7679	0,6333	0,6167	-0,3929	-0,6071	-0,4286	0,0000
TR	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7167	0,3393	0,7500	0,6667	0,8571	0,6333	0,8214	0,6833	0,7308	0,4821	0,7500	0,6071	0,5000	0,7167	0,7667	0,0000
VI	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	10,000	0,6071	0,7679	0,5167	0,8214	0,6333	0,8214	0,6786	0,6923	0,6000	0,6964	0,7333	0,5357	0,5893	0,6500	0,8667
BE	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,5893	10,000	0,5357	0,7321	0,8036	0,8214	0,7000	0,6333	0,6250	0,5000	0,6429	0,7333	0,4167	0,6607	0,7333	0,6333
IN	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7500	0,4821	10,000	0,6333	0,8077	0,6333	0,8036	0,8667	0,6923	0,7143	0,6607	0,7500	0,6250	0,5385	0,7308	0,9000
CU	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,5714	0,6964	0,5000	10,000	0,7143	0,6964	0,7143	0,6250	0,7500	0,6667	0,8462	0,6607	0,5000	0,5357	0,6964	0,8167
EX	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,8077	0,7083	0,6923	0,6071	10,000	0,8571	0,8214	0,6538	0,6731	0,6042	0,6346	0,6538	0,5208	0,6346	0,7500	0,9000
LO	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7292	0,7500	0,6607	0,7500	0,8929	10,000	0,8500	0,7083	0,6250	0,4038	0,6731	0,7292	0,5000	0,6250	0,7917	0,7833
PR	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7857	0,5893	0,7143	0,7500	0,8167	0,8571	10,000	0,7292	0,7308	0,6042	0,7308	0,7885	0,5208	0,7083	0,8125	0,8833
CH	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7692	0,6136	0,8846	0,6786	0,8333	0,7679	0,6964	10,000	0,8462	0,8077	0,7143	0,7885	0,6364	0,5577	0,7500	0,8833
IV	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7692	0,6042	0,7500	0,6875	0,7679	0,6071	0,7308	0,8000	10,000	0,8269	0,7500	0,7885	0,5833	0,7273	0,6923	0,8167
IT	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,7308	0,4423	0,8214	0,5625	0,6429	0,6154	0,6818	0,8393	0,7885	10,000	0,7500	0,6346	0,6346	0,5417	0,5962	0,7167
MG	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6786	0,6458	0,6346	0,8571	0,7321	0,7115	0,7679	0,6538	0,8571	0,6875	10,000	0,8958	0,5769	0,7308	0,8750	0,8750
MK	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,9038	0,8846	0,7500	0,7083	0,8462	0,8750	0,8571	0,7500	0,7308	0,6154	0,7679	10,000	0,5962	0,7885	0,8077	0,8571
NT	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6154	0,5192	0,7273	0,5000	0,6667	0,5536	0,6923	0,7500	0,6538	0,6667	0,6786	0,6071	10,000	0,5357	0,5625	0,7143
PF	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6154	0,6429	0,7000	0,5536	0,8333	0,7667	0,8036	0,6429	0,7500	0,5000	0,6000	0,7833	0,6000	10,000	0,7500	0,7500
SA	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,8667	0,7679	0,7321	0,6667	0,7857	0,8393	0,7857	0,6250	0,5714	0,5417	0,7143	0,8393	0,4808	0,7167	10,000	0,8214
OM	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	10,000

Table 6
Simulation scenarios.

Scenario	Objectives	Constraints/Value Repositories
Scenario 1	More critical situation (stronger constraints)	Transformation of the process and the traditional way of selling Adoption costs of new technologies Customer approach
Scenario 2	Strengthening of the most influential value repositories in relation to marketing	Analysis of customer data (360 vision) Customer-centric proposition Portfolio of products and services Digital channels
Scenario 3	Strengthening the value repositories that most strongly impact omnichannel	Customer experience Marketing Management Analysis of customer data (360 vision) Customer-centric proposition

$$x_i(t) = f\left(\sum_{j=1;j\neq i}^{n} x_j(t-1)\omega_{ji}\right)$$

where f is the sigmoid function:

$$f = \frac{1}{1+e^{-\lambda x}}$$

This function determines the type of FCM to choose. The sigmoid has been chosen in this research since sigmoid FCMs are "*suitable for qualitative and quantitative problems where the representation of a degree of increase, a degree of decrease or stability of a concept is required and the strategic planning scenarios are going to be introduced*" (Tsadiras, 2008).

The learning goal of FCMs is to compute a weight matrix that best fits the decision-making and prediction problems. "*Learning algorithms can train FCMs, which means the adjustment of the strength connections (weights) among concepts* (constraints and value repositories), *as in the case of synapses of neural networks*" (Papageorgiou, 2012). The algorithm used in this research has been Differential Hebbian Learning (DHL). Differential Hebbian Learning encodes how changes in one concept map to changes in another concept. "*The discrete change ΔAC_i lies in [−1,1]. So $\Delta AC_i \Delta AC_j > 0$ iff concepts C_i and C_j move in the same direction. $\Delta AC_i \Delta AC_j < 0$ iff concepts C_i and C_j move in the opposite direction. The discrete update equation for differential Hebbian learning is $\omega_{ij}(t+1) = \omega_{ij}(t) + \gamma(t)[\Delta C_i \Delta C_j - \omega_{ij}(t)]$ if $\Delta C_i \neq 0$, and $w_{ij}(t+1) = \omega_{ij}(t)$ if $\Delta C_i = 0$, where $\gamma(t)$ is a decreasing learning coefficient. The weight matrix updates only when a causal change occurs at the input*" (Dickerson & Kosko, 1994).

"*During DHL learning, the values of weights are iteratively updated until the desired structure is found. The weights of outgoing edges for each concept in the connection matrix are modified only when the corresponding concept value changes*" (Papageorgiou, 2012).

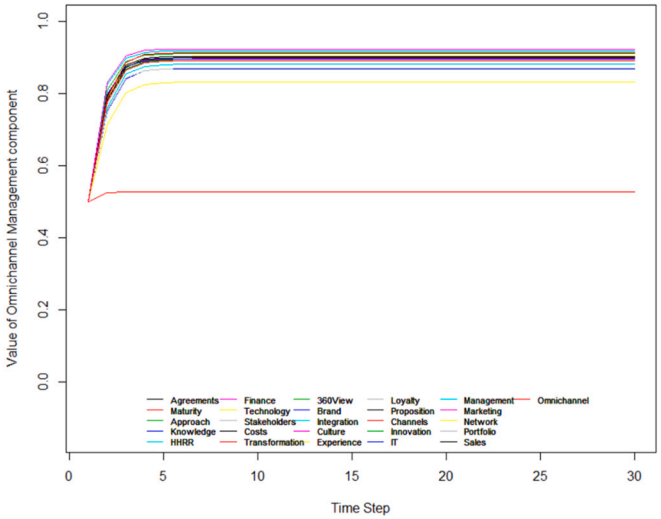


Fig. 10. Reference scenario.

4.4. Simulation

"*We can undertake some interesting 'what-if' analyses using FCM*" (Hester, 2015). "*Exploiting adjacency matrix describing FCM, what-if simulation is performed by multiplying the input configuration vector representing the state of each node with the adjacency matrix. The value for each element of the input case can be*" any in the interval [1,-1] (De Maio et al., 2015).

Based on the relevance of the value repositories and the constraints gathered in Delphi, the following what-if scenarios have been defined in Table 6:

For the inference from the FCM, the current commercial circumstances of one of the companies to which one of the panelists belongs can be used (Lee et al., 2013) However, to compare the scenarios, in this research a random vector with all the concepts set to 0.5 has been used as the first input to get the baseline scenario against which to compare the subsequent simulations. The simulation results for the baseline scenario are shown in Fig. 10.

Table 7 shows the results of the baseline scenario with which we will compare the what-if scenarios.

For the base vector chosen, it is observed that the most important value repositories are marketing management, management leadership and innovation. Those that have the least influence on Omnichannel Management as a result of this base simulation are the brand, the portfolio of products or services and the integration of the channels.

4.4.1. Scenario 1: More critical situation (stronger constraints)

A 'what-if' simulation was conducted to assess the impact of a more critical situation in relation to the constraints that impact Omnichannel Management. Taking into consideration the most influential constraints, this scenario was marked by difficulties in the process of transforming sales into this new omnichannel situation, an increase in the cost of adopting new technologies, and greater difficulties in approaching the customer. Table 8 only shows the vector values that change with respect to the inference vector of the base scenario.

To provide decisional support from FCM in control, Table 9 and Fig. 11 "*show the simulation results and corresponding outputs for the values obtained at* n *iteration execution*" (De Maio et al., 2015). In Table 9, the results show the percentage deviation of the final values with respect to those obtained for the baseline scenario.

We can see that, as a result of the simulation, Omnichannel Management efficiency is expected to decrease if the general conditions tighten. It is worth noting that this scenario significantly affects the two most strategic repositories whose return is most evident in the long term, namely corporate culture and innovation. The drop in IT management is also significant. It could therefore be deduced that, in the face of more negative business scenarios, the economic focus turns to those activities that can give the greatest return in the short term.

The three value repositories that have the most weight in the baseline scenario (marketing management, management leadership and innovation) are within the top five most affected in this scenario with tougher conditions. However, the three value repositories with the least weight in the baseline scenario have an unequal impact on each other, with the brand being the most pronounced.

4.4.2. Scenario 2: implementation of the main marketing-related processes

In a similar way to the previous scenario, a "what if" simulation was carried out to evaluate the result of an improvement in the processes oriented to the proposition and customer sales. Once again, Table 10

Table 7
Output vector for the base scenario.

Base Scenario: Outcome state vector					
360View	0.8953102	Innovation	0.8907309	Marketing	0.9191858
Brand	0.8694332	Integration	0.9004129	Network	0.9243975
Channels	0.8820055	IT	0.8927432	Portfolio	0.8318582
Culture	0.8974754	Loyalty	0.9118432	Proposition	0.8702592
Experience	0.9042192	Management	0.8967236	Sales	0.9038871
Omnichannel Management					
Omnichannel					0.9142983

Table 8
Input vector for the first scenario.

Model component	Input value
Approach	−0.9
Costs	−0.9
Transformation	−0.9

only shows the values of the vectors that change with respect to the inference vector of the base scenario.

In the same way as for the previous scenario, Table 11 and Fig. 12 show the results of the simulation and the corresponding outputs.

The results derived from implementing better marketing-oriented processes (excluding those values that are part of the input vector) show that the values that are, relatively, most affected are those that have a direct relationship with the client (loyalty and improvement of the experience), together with aspects such as the management of the distribution network and the integration of the channels themselves. In absolute terms, the values that benefited most are those related to general management, especially marketing management. In any case, the impact on Omnichannel Management has less relative significance than the previous impact resulting from the constraints (Scenario #1).

The three value repositories that have the most weight in the baseline scenario (marketing management, management leadership and innovation) remain the most important in this simulation if the repositories that are part of the input vector are not considered. However, they are the ones with the least relative increase. On the other hand, repositories with less weight in the baseline scenario, such as integration and the brand, are those that experience a greater relative increase under the conditions included in this scenario.

4.4.3. Scenario 3: management of more productive assets

The third simulation is performed to evaluate the impact of the most important values according to the analysis in Table 4. The input vector to this new "what-if" scenario only changes the values shown in Table 12 with respect to the base scenario.

In view of the results (see Figure 13 and Table 13), it is possible to conclude that the improvement in customer experience, with an accurate value proposition, better customer knowledge and better marketing management, favors the management of the distribution network and the positioning of the brand, in relative values; while favoring leadership in management and innovation in absolute values. However, as in scenario 2, the relative effect on Omnichannel Management in this scenario is less than in scenario 1. In other words, constraints have a greater relative effect than value repositories. It is also striking that the expected effect on Omnichannel Management is lower in these supposedly more productive values than those directly related to Marketing, based on the results of scenario 2.

The value repositories with greater and less weight in the base scenario follow the same trends as those described in scenario 2. Thus, the value repositories that have the most weight in the base scenario

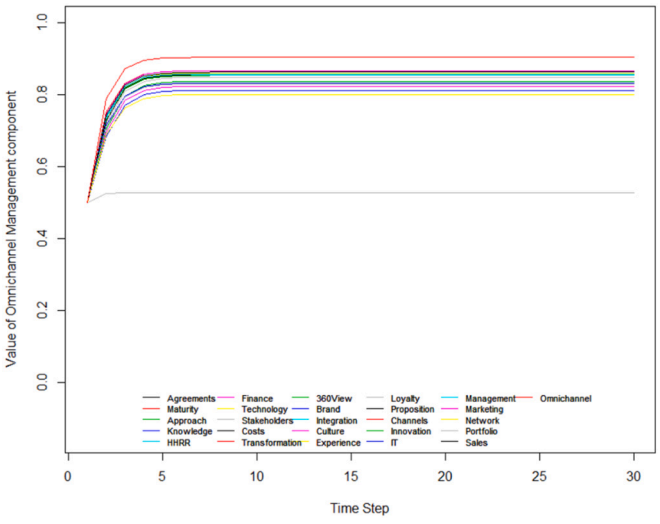


Fig. 11. Inference output for the first scenario.

Table 10
Input vector for the second scenario.

Model component	Input value
360 View	0.95
Proposition	0.95
Portfolio	0.95
Channels	0.95

Table 9
Output vector for the first scenario.

Scenario 1: A tougher business environment								
360View	0,85,427	−4,6%	Innovation	−8,2%	0,4%	Marketing	0,86,685	−6,2%
Brand	0,81,189	−6,6%	Integration	−2,9%	0,5%	Network	0,80,078	−3,7%
Channels	0,86,675	−2,9%	IT	−7,1%	0,4%	Portfolio	0,83,072	−4,5%
Culture	0,82,347	−8,2%	Loyalty	−4,7%	0,5%	Proposition	0,85,691	−4,8%
Experience	0,85,954	−4,9%	Management	−6,6%	0,3%	Sales	0,86,338	−4,5%
Omnichannel Management								
Omnichannel				0.90451				−1,07%

Table 11
Output vector for the second scenario.

Scenario 2: implementation of the main processes linked to marketing								
360View	0.95000	6.1%	Innovation	0.91517	0.4%	Marketing	0.92737	0.3%
Brand	0.87337	0.5%	Integration	0.88635	0.5%	Network	0.83637	0.5%
Channels	0.95000	6.4%	IT	0.89992	0.4%	Portfolio	0.95000	9.2%
Culture	0.90067	0.4%	Loyalty	0.89479	0.5%	Proposition	0.95000	5.5%
Experience	0.90815	0.4%	Management	0.92199	0.3%	Sales	0.90744	0.4%
Omnichannel Management								
Omnichannel				0.91794				0.40%

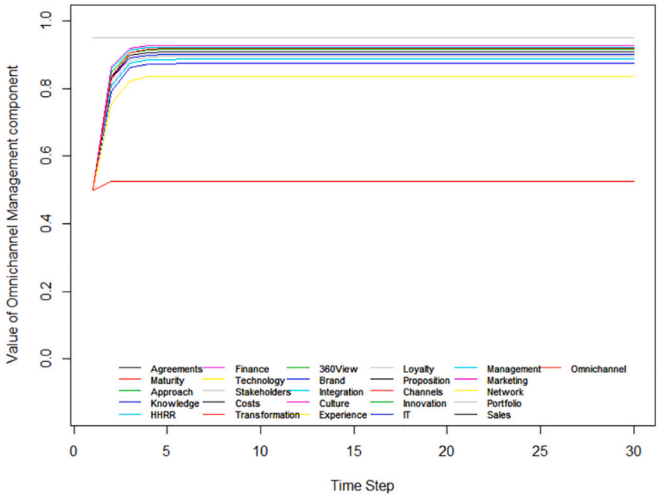


Fig. 12. Inference output for the second scenario.

Table 12
Input vector for the third scenario.

Model component	Input value
Experience	0.95
Proposition	0.95
Marketing	0.95
360View	0.95

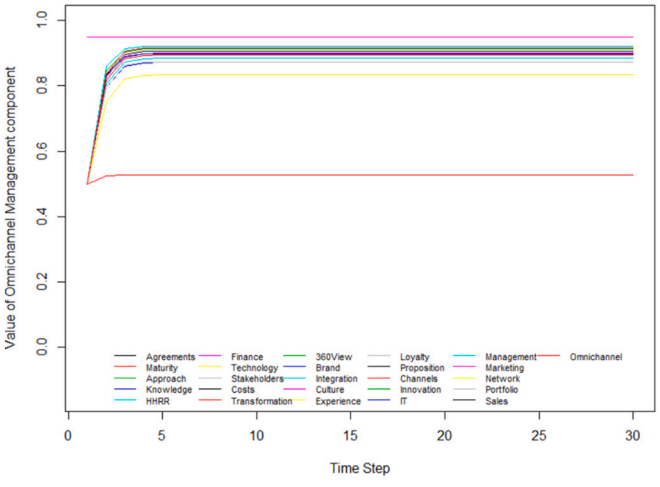


Fig. 13. Inference output for the third scenario.

continue to be the most important in this simulation, without taking into account the repositories that are part of the input vector. At the same time, they are the ones with the smallest relative increases. On the other hand, the three repositories with the least weight in the baseline scenario (channel integration, portfolio and brand) are the ones that experience the greatest relative increases under the conditions set out in this scenario.

5. Discussion of results

To summarize the data obtained, the following can be concluded:

1. The impacts that value repositories have on Omnichannel Management are not the same for all of them. Similarly, some constraints have a more pronounced impact on value repositories than others.
2. It can be expected that, of the most significant constraints, three stand out. These are: the transformation of the process and the traditional way of selling; the costs of adopting new technologies; and the customer approach.
3. The value repositories most affected by the constraints are the customer-centric proposition and channel integration. In the opposite case, the value repository "the distribution and supply chain network" stands out as having less impact.
4. The model obtained from Delphi shows a strong interconnection between value repositories.
5. The interconnection between value repositories and Omnichannel Management is principally revealed to be "strong" and "very strong".
6. The greatest impact on companies' Omnichannel Management comes from three value repositories: Customer data analysis (360 view), Channel integration and Digital channels.
7. Of all the value repositories, Customer Experience has the greatest impact, with other marketing-related value repositories, such as 360 Vision, Customer-centric Value Proposition, and Marketing Management itself, following closely in importance.
8. The omnichannel B2B business value creation network is divided into five interconnected clusters. These same clusters connect to each other with different connection weights.
9. Two of the most influential value repositories in the baseline scenario, namely management leadership and innovation, are strongly affected in a scenario with more pronounced constraints (scenario 1). However, they are among the least impacted by changes in other value repositories (scenarios 2 and 3).
10. Two of the value repositories with the least influence in the baseline scenario, namely the distribution network and channel integration, are the least affected by the constraints and yet the most impacted in the scenarios that include changes in the value repositories, excluding the repositories of values that are part of the input vector in each scenario.

The results of the network model simulations have important management implications: Constraints on omnichannel implementation,

Table 13
Output vector for the third scenario.

Scenario n. 3: more productive asset management								
360View	0.95000	6.1%	Innovation	0.91415	0.3%	0.95000	2.8%	0.95000
Brand	0.87251	0.4%	Integration	0.88509	0.3%	0.83497	0.4%	0.83497
Channels	0.89548	0.3%	IT	0.89903	0.3%	0.87330	0.3%	0.87330
Culture	0.89988	0.3%	Loyalty	0.89382	0.3%	0.95000	5.5%	0.95000
Experience	0.95000	5.1%	Management	0.92131	0.2%	0.90651	0.3%	0.90651
Omnichannel Management								
Omnichannel				0.9173206				0.33%

such as transforming the sales process, taking a greater and better focus on the customer, and reducing costs to adopt new technologies, should preferably be mitigated. Mitigating constraints will be more effective than actions such as encouraging marketing activities, modifying the value proposition, or enabling more digital channels.

Based on the resulting model and the simulation scenarios, it can be concluded that Omnichannel Management in the B2B environment is far more significantly affected by the constraints on creating value in companies than by the principal activities, resources and processes (value repositories) that are directly linked to Omnichannel Management. In other words, based on the model and the simulation, Omnichannel Management in manufacturers and wholesalers should be aimed at reducing the costs of adopting new technologies or at transforming the traditional sales process, rather than at actions such as encouraging the proliferation of more digital channels or improving marketing management in the organization.

6. Conclusions

6.1. Theoretical and methodological implications

Due to the shortage of studies on Omnichannel Management in the B2B field, our study provides the first model that brings together the main elements that influence optimal Omnichannel Management in the industrial field. The model also captures the impacts that the constraints that the company is facing have on Omnichannel Management.

The model we have presented is considered to provide both theoretical and practical benefits to any company undertaking a digital transformation, given that it makes it possible to think through the expected performance metrics a priori and permits a benchmarking framework to be created for the management initiatives to be addressed. More specifically, fuzzy cognitive mapping makes it possible to study an organization's performance and anticipate any unwanted secondary effects of actions in the company.

To date, most of the research listed in Table 1 analyzes the impact that each variable has on Omnichannel Management separately; in some cases, two variables are reviewed, such as price and channel (Kim & Chun, 2018; Modak & Kelle, 2019). The cognitive map facilitates the decomposition into variables and their interrelations. These variables and interrelations constitute a valid construct that coincides with the complexity of the companies. The level of engagement achieved by Panel Members and the quality of contributions support the view that the complex model approach enables a flexible and realistic understanding of companies and the interactions that shape their behavior.

As a theoretical assessment, it is appropriate to contrast the results of the study with the research published and listed in Table 1. The first block of research attempts to characterize customer behavior. The model created in this study collects behavior in two main variables defined by customer experience (EX) and customer loyalty (LO) and a principal constraint which is the lack of knowledge and customer data (KN). This situation agrees with the articles published and the lines of research already mentioned, although it reveals one of the main problems to be solved in the model, which is how the measurement of customer experience is carried out in an omnichannel environment (Lemon & Verhoef, 2016).

The strategy by channel and price is given in the model by two value repositories: channel integration (IN), digital channels (CH); and constraints such as the maturity of the channel (MT). In the published studies, channel integration and digital channels are widely studied. Maturity can be associated with studies on cannibalization (Kim & Chun, 2018) and dual channel management (Modak & Kelle, 2019), so the model would be aligned with published research.

In the model, logistics is represented by a single value repository, namely network (NT). However, as shown in Table 1, this is the field in which there has been the greatest scientific contribution to date. Research into this area within Omnichannel Management, at least in the retail field, has been extensive. It is therefore worth asking whether the model is limited to a single variable, which is also the one with the lowest absolute weight in all the scenarios, although it is the one with the greatest relative change in the simulations in which the value repositories are improved (scenarios 2 and 3). There are multiple studies on issues and opportunities in forward and reverse logistics, fulfillment, warehouse impact, coexistence with the traditional distribution channel, among others. And yet the model is reduced to a single variable. In the opinion of the authors, this is an aspect that needs to be explored, either to endorse the model or to enrich it. But if the model is endorsed, and in Omnichannel Management logistics is not one of the principal values, then research in the other fields becomes more pressing.

The IT-related impact is included in the model through the IT management value repository (IT) and two constraints. These are the integration of new technology with corporate systems (TE) and the cost of adopting the new technology (CO). It can be concluded that the model is aligned with the published literature regarding IT management. Several articles have also been published on specific technology in different contact points, but according to the panelists, this technology is not relevant enough to be part of a general model.

Finally, one of the contributions that the model presents is the disparity of variables (VI, BR, CU, PR, IV, MG, MK, PF, SA) and constraints (AG, AP, HR, FI, ST, TR) that occur in the area of "management". The scope is very broad, but when the research to date is grouped in Table 1, such a broad concept reveals the vast field of potential research into Omnichannel Management in general. Each value repository and constraint identified within the "Omnichannel Management" field constitutes an area in the omnichannel field that could be researched. For example, no articles have been found that address the value repositories or the constraints linked to the organization from the perspectives of leadership (MG), recruitment of human resources (HR), definition of roles or the internal organization/stakeholders (ST) In contrast, the perspectives of impact on the sales force, the personnel in the physical store and customer service (SA) have been studied.

6.2. Managerial implications. Relationship

According to the findings of this research, Omnichannel Management in a B2B environment is more strongly impacted by constraints than by variables in its favor. In other words, a more restrictive

environment entails a greater impact on Omnichannel Management than any attempts to improve the context of the variables that favor such management.

Thus, for example, if we review how the Channel Integration value repository has been treated in research to date (see Table 1), it can be concluded that greater channel integration has a positive impact on Omnichannel Management (Cao & Li, 2015; Herhausen, Binder, Schoegel, & Herrmann, 2015). Our study confirms this conclusion, given that a new channel (scenario 2) favors Omnichannel Management. However, from a management point of view, it would be advisable to make a greater effort to mitigate negative scenarios such as the one shown in scenario 1, instead of opening a new channel.

This exercise also reveals that applying a complexity-based vision of the organization can offer a wide range of options for better addressing a company's true situation and from here, evaluate "what-if" scenarios that will facilitate the decision-making (Xirogiannis & Glykas, 2007). The model created in the study does not pretend to be a true reflection of reality, but rather a tool to help decision-making, which, based on the experience of experts, makes it possible to highlight the main variables that influence Omnichannel Management and the impacts between them. "*Models are open to review by all relevant stakeholders, including critics, and modelers seek out opportunities to confront the model with data and test assumptions*" (Sterman, 2015). "*The benchmark for FCM "validation" should therefore be if it adequately describes what the respondents know about the subject matter, which requires them to take an active role in model testing*" (A. J. Jetter & Kok, 2014)

6.3. Limitations and further research

The investigation starts with a Delphi process, to build the model. This is one of the main limitations of the study. For Delphi to be relevant, three main conditions must be met (J. Skulmoski, Hartman, & Krahn, 2007):

- *"Heterogeneous or homogeneous sample: when the group is homogeneous, a smaller sample of between ten and fifteen people can give enough results.*
- *Trade-off between decision quality/Delphi manageability: there is a reduction in group error (or an increase in decision quality) as the sample size increases.*
- *Internal or external verification: The larger the group, the more convincingly it can be said that the results are verified.*"

The selection of experts with similar training and general knowledge in the field of interest allows the efficient and reliable use of "*a small sample of a limited number of experts in the field of study*" (Akins et al., 2005). The 30 selected panelists have a managerial profile and work in companies in the B2B field, whether they are manufacturers or wholesalers. However, the international nature of the sample, the different sizes of the companies, and the diversity of sectors, are factors that could be adjusted for a more accurate result: by geographic scope, industry, company size and/or type of company in a traditional supply chain.

Other limitations come from the process of creating the FCM itself. With the use of DHL, we are accepting one of "*the main drawbacks of this approach, which is that the formula updates weights between each pair of concepts, taking into account only these two concepts and ignoring the influence that comes from other concepts*" (Papageorgiou, 2012). Other learning methods could be used, such as active HL or online HL. However, the model resulting from this research does not invalidate the contrast with what-if scenarios, if these are considered from a qualitative rather than a quantitative point of view.

However, the above limitations do not invalidate the applicability of the complexity-based research in addressing the true situation of companies, nor should its results be neglected.

A possible future task would be to assess the validity of the FCM model that has been identified. If the FCM model reproduces with some accuracy the Omnichannel Management processes in each of the organizations of the experts who have been part of the Delphi process. However, it should be noted that when using calibrated FCM there is "*a temptation to see their predictions as the truth about how the future will unfold, when what they truly provide are alternative and often competing ideas on ways in which it may unfold*" (A. J. Jetter & Kok, 2014).

The model includes an evaluation of which traditional processes are most affected in this new Omnichannel Management and, to some extent, how management efficiency is characterized, defined and measured in a company that accepts the need for continuous adaptation to an increasingly diverse and changing demand. As a line of research, this model could be iterated—either on companies in a specific industry, or with different positions in the value chain (manufacturers vs. wholesalers) or company sizes—to infer more specific models. Likewise, it is necessary to define which indicators are key to Omnichannel Management for industrial clients and, if possible, how these could be measured. This would make it possible to define strategies in advance and to measure business performance once these strategies have been addressed, in order to facilitate continuous internal analysis and comparison between companies in the same sector.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2018.03.009.

References

Akins, R. B., Tolson, H., & Cole, B. R. (2005). Stability of response characteristics of a Delphi panel: application of bootstrap data expansion. *BMC Medical Research Methodology, 5*(1), 37. https://doi.org/10.1186/1471-2288-5-37.

Alonso-Garcia, J., Pablo-Martí, F., & Nunez-Barriopedro, E. (2021). Omnichannel Management in a B2B context: Concept, research agenda and bibliometric review. *International Journal of Industrial Engineering and Management Review, 12*(1), 1–12. https://doi.org/10.24867/IJIEM-2021-1-275.

Avery, J., Steenburgh, T. J., Deighton, J., & Caravella, M. (2013). Adding Bricks to Clicks: On the Role of Physical Stores in a World of Online Shopping. *GfK Marketing Intelligence Review, 5*(2), 28–33. https://doi.org/10.2478/gfkmir-2014-0015.

Börner, K., Chen, C., & Boyack, K. W. (2005). Visualizing knowledge domains. *Annual Review of Information Science and Technology, 37*(1), 179–255. https://doi.org/10.1002/aris.1440370106.

von Briel, F. (2018). The future of omnichannel retail: A four-stage Delphi study. *Technological Forecasting and Social Change, 132*(February), 217–229. https://doi.org/10.1016/j.techfore.2018.02.004.

Brynjolfsson, E., Hu, Y. J., & Rhaman, M. S. (2013). Competing in the Age of Omnichannel Retailing. *MIT Sloan Management Review, 54*(June), 23–29. Retrieved from https://courses.helsinki.fi/sites/default/files/course-material/4482615/17.3_MIT_Brynjolfsson.pdf.

Buratti, N., Parola, F., & Satta, G. (2018). Insights on the adoption of social media marketing in B2B services. *The TQM Journal, 30*(5), 490–529. https://doi.org/10.1108/TQM-11-2017-0136.

Butts, C. T. (2008). network: A package for managing relational data in R. *Journal of Statistical Software, 24*(2). https://doi.org/10.18637/jss.v024.i02.

Cao, L., & Li, L. (2015). The impact of cross-channel integration on retailers' sales growth. *Journal of Retailing, 91*(2), 198–216. https://doi.org/10.1016/j.jretai.2014.12.005.

Chung, C., Chatterjee, S. C., & Sengupta, S. (2012). Manufacturers' reliance on channel intermediaries: Value drivers in the presence of a direct web channel. *Industrial Marketing Management, 41*(1), 40–53. https://doi.org/10.1016/j.indmarman.2011.11.010.

Cunningham, K. M. (1972). Evaluation of hierarchical grouping techniques: A preliminary study. *The Computer Journal, 15*(3), 209–213. https://doi.org/10.1093/comjnl/15.3.209.

De Maio, C., Botti, A., Fenza, G., Loia, V., Tommasetti, A., Troisi, O., & Vesci, M. (2015). What-if analysis combining Fuzzy Cognitive Map and Structural Equation Modeling. In *2015 Conference on Technologies and Applications of Artificial Intelligence (TAAI)* (pp. 89–96). IEEE. https://doi.org/10.1109/TAAI.2015.7407094.

Dickerson, J. A., & Kosko, B. (1994). Virtual worlds as Fuzzy Cognitive Maps. *Presence Teleoperators and Virtual Environments, 3*(2), 173–189. https://doi.org/10.1162/pres.1994.3.2.173.

Gallino, S., & Moreno, A. (2014). Integration of online and offline channels in retail: The impact of sharing reliable inventory availability information. *Management Science, 60*(6), 1434–1451. https://doi.org/10.1287/mnsc.2014.1951.

von der Gracht, H. A. (2012). Consensus measurement in Delphi studies. *Technological Forecasting and Social Change, 79*(8), 1525–1536. https://doi.org/10.1016/j.techfore.2012.04.013.

Hadjikhani, A., & LaPlaca, P. (2013). Development of B2B marketing theory. *Industrial Marketing Management, 42*(3), 294–305. https://doi.org/10.1016/j.indmarman.2013.03.011.

Herhausen, D., Binder, J., Schoegel, M., & Herrmann, A. (2015). Integrating bricks with clicks: Retailer-level and channel-level outcomes of online–offline channel integration. *Journal of Retailing, 91*(2), 309–325. https://doi.org/10.1016/j.jretai.2014.12.009.

Hester, P. (2015). Analyzing stakeholders using Fuzzy Cognitive Mapping. *Procedia Computer Science, 61*(October), 92–97. https://doi.org/10.1016/j.procs.2015.09.159.

Ilchenko, N., Kulik, A., & Magda, R. (2018). Trends in development of wholesale trade in Ukraine. *Economic Annals-XXI, 170*(3–4), 38–42. https://doi.org/10.21003/ea.V170-07.

Jetter, A. (2006). Fuzzy Cognitive Maps for Engineering and Technology Management: What Works in Practice?. In *, vol. 2. 2006 Technology Management for the Global Future - PICMET 2006 Conference* (pp. 498–512). IEEE. https://doi.org/10.1109/PICMET.2006.296648.

Jetter, A. J., & Kok, K. (2014). Fuzzy Cognitive Maps for futures studies—A methodological assessment of concepts and methods. *Futures, 61*(October 2017), 45–57. https://doi.org/10.1016/j.futures.2014.05.002.

Kalantari, T., & Khoshalhan, F. (2018). Readiness assessment of leagility supply chain based on fuzzy cognitive maps and interpretive structural modeling: a case study. *Journal of Business & Industrial Marketing, 33*(4), 442–456. https://doi.org/10.1108/JBIM-01-2017-0008.

Kembro, J. H., Norrman, A., & Eriksson, E. (2018). Adapting warehouse operations and design to omni-channel logistics. *International Journal of Physical Distribution and Logistics Management, 48*(9), 890–912. https://doi.org/10.1108/IJPDLM-01-2017-0052.

Kim, J. C., & Chun, S. H. (2018). Cannibalization and competition effects on a manufacturer's retail channel strategies: Implications on an omni-channel business model. *Decision Support Systems, 109*(January), 5–14. https://doi.org/10.1016/j.dss.2018.01.007.

Kolaczyk, E. D., & Csárdi, G. (2014). Statistical analysis of network data with R. *Journal of Statistical Software, 66*(Book Review 1), 1–6. https://doi.org/10.18637/jss.v066.b01.

Konuş, U., Neslin, S. A., & Verhoef, P. C. (2014). The effect of search channel elimination on purchase incidence, order size and channel choice. *International Journal of Research in Marketing, 31*(1), 49–64. https://doi.org/10.1016/j.ijresmar.2013.07.008.

Lee, K. C., Lee, H., Lee, N., & Lim, J. (2013). An agent-based fuzzy cognitive map approach to the strategic marketing planning for industrial firms. *Industrial Marketing Management, 42*(4), 552–563. https://doi.org/10.1016/j.indmarman.2013.03.007.

Leeflang, P. S. H., Verhoef, P. C., Dahlström, P., & Freundt, T. (2014). Challenges and solutions for marketing in a digital era. *European Management Journal, 32*(1), 1–12. https://doi.org/10.1016/j.emj.2013.12.001.

Leek, S., & Christodoulides, G. (2011). A literature review and future agenda for B2B branding: Challenges of branding in a B2B context. *Industrial Marketing Management, 40*(6), 830–837. https://doi.org/10.1016/j.indmarman.2011.06.006.

Lemon, K. N., & Verhoef, P. C. (2016). Understanding customer experience throughout the customer journey. *Journal of Marketing, 80*(6), 69–96. https://doi.org/10.1509/jm.15.0420.

Mirghafoori, S. H., Morovati Sharifabadi, A., & Karimi Takalo, S. (2018). Development of causal model of sustainable hospital supply chain management using the Intuitionistic Fuzzy Cognitive Map (IFCM) method. *Journal of Industrial Engineering and Management, 11*(3), 588. https://doi.org/10.3926/jiem.2517.

Modak, N. M., & Kelle, P. (2019). Managing a dual-channel supply chain under price and delivery-time dependent stochastic demand. *European Journal of Operational Research, 272*(1), 147–161. https://doi.org/10.1016/j.ejor.2018.05.067.

Neslin, S. A., Grewal, D., Leghorn, R., Shankar, V., Teerling, M. L., Thomas, J. S., & Verhoef, P. C. (2006). Challenges and opportunities in multichannel customer management. *Journal of Service Research, 9*(2), 95–112. https://doi.org/10.1177/1094670506293559.

Nezami, M., Worm, S., & Palmatier, R. W. (2018). Disentangling the effect of services on B2B firm value: Trade-offs of sales, profits, and earnings volatility. *International Journal of Research in Marketing, 35*(2), 205–223. https://doi.org/10.1016/j.ijresmar.2017.12.002.

Obal, M., & Lancioni, R. A. (2013). Maximizing buyer–supplier relationships in the Digital Era: Concept and research agenda. *Industrial Marketing Management, 42*(6), 851–854. https://doi.org/10.1016/j.indmarman.2013.06.002.

Palmatier, R. W., Gopalakrishna, S., & Houston, M. B. (2006). Returns on business-to-business relationship marketing investments: Strategies for leveraging profits. *Marketing Science, 25*(5), 477–493. https://doi.org/10.1287/mksc.1060.0209.

Papageorgiou, E. I. (2012). Learning algorithms for fuzzy cognitive maps - A review study. *IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews, 42*(2), 150–163. https://doi.org/10.1109/TSMCC.2011.2138694.

Piotrowicz, W., & Cuthbertson, R. (2014). Introduction to the special issue information technology in retail: Toward Omnichannel retailing. *International Journal of Electronic Commerce, 18*(4), 5–16. https://doi.org/10.2753/JEC1086-4415180400.

Rigby, D. (2011). The future of shopping. *Harvard Business Review*, 1–14 (December). Retrieved from https://hbr.org/2011/12/the-future-of-shopping.

Russo, I., & Confente, I. (2017). *Customer loyalty and supply chain management: Business-to-business customer loyalty analysis*. Routledge. https://doi.org/10.4324/9781315162829.

Skulmoski, J., Hartman, T., & Krahn, J. (2007). The Delphi method for graduate research. *Journal of Information Technology Education: Research, 6*, 01–21. https://doi.org/10.28945/199.

Sterman, J. D. (2015). Business dynamics, system thinking and modeling for a complex world. *Massachusetts Institute of Technology Engineering Systems Division*. https://doi.org/10.4135/9781483347660.n269 (April 2002).

Strojny, S., & Chromińska, M. (2016). Processes of concentration of wholesale trade in Poland in the light of empirical research. *Scientific Journal of Logistics, 12*(3), 247–257. https://doi.org/10.17270/J.LOG.2016.3.5.

Stylios, C. D., & Groumpos, P. P. (1999). Mathematical formulation of Fuzzy Cognitive Maps. In *Proceedings of the 7th Mediterranean Conference on Control and Automation (MED99)* (pp. 2251–2261). Retrieved from https://kic.uoi.gr/wp-content/uploads/2020/04/Mathematical-Formulation-of-Fuzzy-Cognitive-Maps.pdf.

Tsadiras, A. K. (2008). Comparing the inference capabilities of binary, trivalent and sigmoid fuzzy cognitive maps. *Information Sciences, 178*(20), 3880–3894. https://doi.org/10.1016/j.ins.2008.05.015.

UNCTAD. (2020). UNCTAD estimates of global e-commerce 2018. Retrieved from https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d12_en.pdf.

Vargo, S. L., & Lusch, R. F. (2011). It's all B2B…and beyond: Toward a systems perspective of the market. *Industrial Marketing Management, 40*(2), 181–187. https://doi.org/10.1016/j.indmarman.2010.06.026.

Verhoef, P. C., Kannan, P. K., & Inman, J. J. (2015). From multi-channel retailing to Omni-channel retailing. *Journal of Retailing, 91*(2), 174–181. https://doi.org/10.1016/j.jretai.2015.02.005.

Xirogiannis, G., & Glykas, M. (2004). Fuzzy cognitive maps in business analysis and performance-driven change. *IEEE Transactions on Engineering Management, 51*(3), 334–351. https://doi.org/10.1109/TEM.2004.830861.

Xirogiannis, G., & Glykas, M. (2007). Intelligent modeling of e-business maturity. *Expert Systems with Applications, 32*(2), 687–702. https://doi.org/10.1016/j.eswa.2006.01.042.