Analyzing of CPFR Supporting Factors in Retail Sector

G. Büyüközkan[1], Z. Vardaloğlu

Abstract—**The retail sector environment is characterized by intense pressure of competition, ever-changing portfolio of products, various customer requirements and sustainability in mass market. Considering giant retailers working together with their suppliers, each independent operation is seen as a comprehensive structure, consisting of thousands of sub-processes. In short, the retail sector's dynamism and cooperative work together with the competitiveness of the sector is a rare combination. In such a sector, businesses of all sizes in many aspects of creating an efficient and low cost structure are in the effort. *CPFR* model which is a scheme integrating trading partners' internal and external information systems is proposed by Voluntary Inter-industry Commerce Standards Association (VICS) to assist establishing a collaborative demand forecasting and replenishment in retail sector. Although CPFR can provide many benefits, there have been many failed implementations. Thus, the aim of this study is to determine factors that will support better implementation of CPFR in retail sector, especially its information sharing sub-system, and analyze them using Fuzzy Cognitive Map (FCM). FCMs have proven particularly useful for solving problems in which a number of decision variables and uncontrollable variables are causality interrelated. Hence the FCM of CPFR is created via expert views to show the relationships between the factors that influence effective implementation of CPFR in retail sector.**

Index Terms—**Collaborative planning, forecasting and replenishment, fuzzy cognitive map, information sharing, retail sector.**

I. Introduction

The retail sector environment is characterized by intense pressure of competition, ever-changing portfolio of products, various customer requirements and sustainability in a mass market. These and many other features of the retail sector make a tough battle field. Another important feature of retail is to create job opportunities to thousands of different companies. Considering giant retailers working together with their suppliers, each independent operation is seen as a comprehensive structure, consisting of thousands of sub-processes. In short, the retail sector's dynamism and cooperative work together with the competitiveness of the sector is a rare combination. Of course in such a sector businesses of all sizes in many aspects of creating an efficient and low cost structure is in the effort. Retail sector has a complex and scattered structure. To Managing hundreds of stores which spread throughout the country, even thousands different stores on a world scale, and to create the same quality of service in each store is quite a tough job. To achieve this, through a centralized information centre to access all customer data, beyond geographical boundaries to ensure effective information sharing is required.

The management of the value chain of retail side is the most challenging one. Retailers who are working with hundreds of different suppliers and who have to manage these relations in dozens of different areas are required to perform a full integration. Creating a transparent structure between these retailer companies and suppliers, performing information sharing with each other effectively, and supporting each other's business processes are required.

CPFR model which is a scheme integrating trading partners' internal and external information systems is proposed by Voluntary Inter-industry Commerce Standards Association (VICS) to assist retailing in establishing a collaborative demand forecasting and replenishment [13]. Though CPFR apparently has had positive effects on supply chain performance [10], there have been many failed implementations. There exist number of previous research focus on the reasons of failure in CPFR implementation and deciding the factors of success in retail sector. These researches used statistical methods such as analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) to determine crucial factors of success CPFR implementation in retail sector [13]. The weak side of these methods is they can not realize the importance of each factor. Thus, to step one further, there is a study on this topic that it offers using fuzzy analytical hierarchy process (Fuzzy AHP) to calculate the weights of each factor to understand the importance and priority of impact factors which influenced CPFR implementation [13].

In this study, it is offered to provide more accurate information as a valuable reference for retail sector. Hence, the aim of this study is to analyze important factors of CPFR, particularly its information sharing sub-system, using fuzzy cognitive map (FCM) approach to support its implementation effectiveness in retail sector. The strengths of all relationships were determined by experts. According to this expertise, we searched the dynamical behavior of model.

FCMs are capable of modeling scenarios described in terms of significant events (or concepts) in the scenario and their cause-effect relationships. One of the most useful aspects of the FCM is its potential for use in decision support as a prediction tool [4]. Given an initial state of a system, represented by a set of values of its constituent concepts, a FCM can simulate its evolution over time to predict its future behavior. These features make FCM a very attractive tool for CPFR supporting factors analysis. To our knowledge, there is

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no previous study that uses cognitive maps or FCMs for CPFR supporting factors assessment in retail sector.

This paper is organized as follows. Section 2 gives an overview of FCMs. This is followed in Section 3 by the supporting factors of one of the sub-system which is information sharing of CPFR. Modeling of this sub-system using FCM is explained in Section 4. The dynamical behavior of this model is investigated in Section 5 and the obtained results are interpreted in Section 6 before the paper is concluded in Section 7.

II. Fuzzy cognitive map

Cognitive maps (CMs) were introduced by Axelrod [2] in the 1970s. CMs are signed diagraphs designed to represent the causal assertions and belief system of a person (or group of experts) with respect to a specific domain, and use that statement in order to analyze the effects of a certain choice on particular objectives. Two elements are used when realizing CMs: concepts and causal belief. Concepts represent the variables that describe the belief system of a person, while the causal belief consists in the causal dependencies between variables. Such variables can be continuous, ordinal or dichotomous [2].

In signed cognitive maps, each relationship is linked to a sign that represents the sense of causal influence of the cause variable on the effect variable. Fig. 1.a) shows a graphical representation of weighted cognitive maps in which the nodes are variable concepts and the edges are causal connections. If the edge from node C_1 to node C_2 is positive, an increase or decrease in C_1 causes a change in the same direction in C_2. If the relationship is negative, the change that the effect variable undergoes is in the opposite direction. With cognitive maps, only centrality of concepts, and direction of the effect of one concept to another can be analyzed.

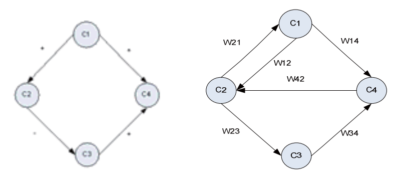

Figure 1. a) An example of a CM, b) An example of a FCM

FCMs were introduced by Kosko [4] to extend the idea of cognitive maps by allowing the concepts to be represented linguistically with an associated fuzzy set rather than requiring them to be precise. In order to describe the degree of the relationship between concepts it is possible to use a number between [0, 1] and [-1, 1], or use linguistic terms, such as ‘‘often’’, ‘‘always’’, ‘‘some’’, ‘‘a lot’’, etc. The representation (Fig.1.b) illustrates different aspects in the behavior of the system showing its dynamics [4] and allowing systematic causal propagation (e.g. forward and backward chaining). The interconnection strength between two nodes C_i and C_j is w_{ij} with $w_{ij} \in [-1, 1]$ in this study.

There are three possible types of causal relationships among concepts:

- $w_{ij} > 0$, positive causality between concepts C_i and C_j
- $w_{ij} < 0$, negative causality between concepts C_i and C_j
- $w_{ij} = 0$, no relationship between concepts C_i and C_j.

The value of each concept is calculated, computing the influence of other concepts to the specific concept, by applying the following calculation rule:

$$A_i^{(k)} = f\left(A_i^{(k-1)} + \sum_{j \neq i} w_{ji} A_j^{(k-1)}\right) \quad (1)$$

where $A_i^{(k)}$ being the value of concept C_i at iteration step k, $A_j^{(k-1)}$ the value of the interconnected concept C_j at iteration step k-1, w_{ij} the weighted arc from C_i and C_j and f a threshold function. Two threshold functions are usually used. The unipolar sigmoid function where $\lambda > 0$ determines the steepness of the continuous function $f(x) = 1/(1+e^{-\lambda x})$. When concepts can be negative and their values belong to the interval [-1, 1] as in our case, function $f(x) = \tanh(x)$ is used. The initial values of each of the concepts of the input vector and the weighted arcs are set to a specific value based on the expert’s beliefs. Thereafter, the system is free to interact. This interaction continues until the model:

- Reaches equilibrium at a fixed point, with the output values, being decimals in the interval, stabilizing at fixed numerical values.
- Exhibits limit cycle behavior, with the output values falling in a loop of numerical values under a specific time period.
- Exhibit a chaotic behavior, with each output value reaching a variety of numerical values in a nondeterministic, random way.

III. Supporting factors of CPFR for retail sector

Based on a detailed literature survey, the factors which influence CPFR success are determined.

A few suppliers or retailers may make deal and share information that can give harm to a partner. Thus, long term supplier partnership and effective partnership selection are trustworthy and reduces the potential for ruinous activities [3], [10] while system comes secure. The leakage effect of information sharing [7], [8], [198] makes managers unwillingness [9], [10], [12], [198]. Thus, trust is an important component of partnerships, and several studies confirm the importance of trust and coordination in cooperative relationships, such as [15], [17], [18], [6], [43]. Joint decision making is also needed in the area of forecasting [3], [24], [11]. Most organizations develop forecasts based on orders receiving from their own customers and upon historical data. If this situation is considered in supply chain, there exists dramatic problems in demand that occurs in functionally oriented supply chains because of the fact that there are multiple forecasts developed by trading partners and each with a small degree of error [15].

The other crucial factor is organizational readiness [1], [14], [22]. While the previous supply chain models used simple tools like spreadsheets in order to satisfy inventory levels and to manage replenishment planning, mature supply chain of today uses advanced planning software that employ cross-functional teams to serve for the same goal. Even latest organizations are characterized by robust process including consensus-based forecasting [1]. Trading partners’ readiness,

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especially technical readiness is also crucial [35].

Understanding CPFR processes, the implications of change, potential benefits of CPFR and the importance of supporting such initiatives can be implemented in a company through the education of the personnel which is another success key factor [1], [10], [254], [5]. From both an internal and external viewpoint, a culture of openness and honesty is needed [44], [28]. By the way it provides trust, respect and commitment as a result of improved certainty and reliability. Heterogeneity and hostility of industrial environment is barrier to adoption [13]. Intra-organizational support in the shape of top management support [15], [5] and in terms of gaining the supports of other parts of the organization e.g. purchasing and manufacturing, that is, cross department support is needed for a process focus for collaboration [15], [25], [21], [12].

Information and communication systems, like EDI [29], [42], [12], [37], [21], [9], [34], [36] and effective database linkages [23], [26], [29], [42] can make collaboration closer to real-time basis for exchanging and utilizing shared information [15]. Partner communication [13] processes and the sharing of information are fundamental to most aspects of organizational functioning. Two aspects of communication behavior that address the extent to which the information exchanged is effective in an alliance include information sharing, and the level of information quality [43], [44], [32], [14], [22] and participation. A clearly identified and broad direct communication channels are also required for openness and intensity of communication [20], [44]. Establishing regularly scheduled meetings with the purpose of discussing the forecast is suggested [16]. The transparency and quality of information flows aspects as the accuracy, timeliness [16], adequacy [3], and reliability [41] plays an important role in supply chain collaboration [14]. Information participation refers to the extent to which partners engage jointly in planning and goal setting [19]. These two information attributes are closely related in a strategic supplier alliance and are critical in enabling both parties to coordinate their activities. It is mentioned that technological connectivity, that is firms' technological capacity, is crucial [35], [8], [11]. However, there are two points that should be considered. One of them is information sharing cost [37], [39], [28], and the other is the systems employed by the partners should be compatible [38] not differences in technologies.

Incentive alignment [40], [34], [12], level of supply chain/logistics integration [8], and high employee involvement [8] are the other supporting factors.

III. Modeling the Information Sharing Sub-System in Retail Sector

Procedure for creating a targeted FCM requires three matrices which are Initial Matrix of Supporting Factors (IMS), Aggregated Matrix of Supporting Factors (AMS) and Weight Matrix of Supporting Factors (WMS). The graphical representation of Weight Matrix gives the FCM [complex].

A. Data Acquisition

Data are collected from interviewing with three experts who are familiar with the CPFR implementation in the retail sector. The backgrounds of these experts are given as following.

One of them worked as a Customer Service Manager, Planning and Logistics Manager in P&G in the area of Turkey, Ukraine, Russia, Middle East, and Caucasian Region. From 2001 to 2008, he worked as a Supply Chain Director in L'Oréal Türkiye. Now he continues his career as a consultant on private logistics projects in his own consulting company. He has some studies about collaborative activities, EDI and score carding. The second one started his career in P&G as a Process Engineer. Then, he moved to Arthur Andersen Consulting and worked on supply chain topics. He served as Distribution Center Manager in L'Oréal Türkiye and after this experience; he worked in DHL Supply Chain Company as an Operation Manager. Other expert started working in L'Oréal Türkiye. After she had some experience in product planning, inventory management, demand forecasting, she has worked as a Customer Service Manager.

The supporting factors which are obtained from the literature survey were asked the experts to evaluate which are the important factors for implementing CPFR, especially for its information sub-system, in retail sector. To do this, the survey sent as e-mail to the experts. After specified these crucial supporting factors which are given in Table I, the pair-wise questionnaire was designed and distributed to experts. Sequentially, the data obtained from the interviews were then used in constructing the IMS for information sharing sub-system.

B. The IMS of Supporting Factors via Experts

The causal interrelationships among concepts are assigned using linguistic variable *Influence* according to expert views about success CPFR implementation in retail sector. This linguistic variable takes values in the Universe U=[-1, 1] and its term set is suggested to comprise nine variables which are negatively very strong (NVS), negatively strong (NS), negatively medium (NM), negatively weak (NW), zero (Z), positively weak (PW), positively medium (PM), positively strong (PS), positively very strong (PVS) shown in Table I.

Table I. The terms of variable *Influence*

Negatively very strong	μ_{nvs}	Negatively strong	μ_{ns}	Negatively medium	μ_{nm}
Negatively weak	μ_{nw}	Zero	μ_z	Positively weak	μ_{pw}
Positively medium	μ_{pm}	Positively strong	μ_{ps}	Positively very strong	μ_{pws}

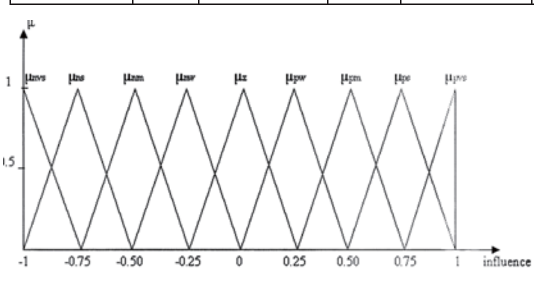

Figure 2. The membership functions of the terms [complex]

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The IMS of supporting factors via experts were structured and because of the page limitation, one expert's IMS matrix is given in Table II.

C. Aggregating the Matrices and Weighting the Matrix

The suggested linguistic weights developed by experts individually are aggregated using the well-known fuzzy logic method of SUM and then the aggregated linguistic weights are produced. While doing this computation, the credibility weight for every expert is considered. In this study, credibilities of each expert are equal. The weights are aggregated by using COG method. Because of the page limitation, one example is given to show how the weights assigned by experts are aggregated. For instance, if expert 1 evaluates that the factor has the influence on the other factor which is described using PM while the others thinks that it is PS, and PVS. This is calculated as above.

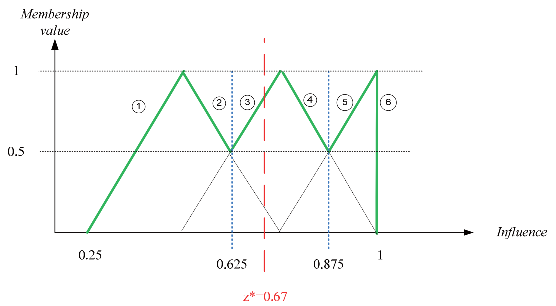

Figure 3. The output of PM-PS-PVS

$$z^*=\frac{\int_{0.25}^{0.5}\frac{(z-0.25)}{0.25}zdz+\int_{0.5}^{0.625}\frac{(z-0.75)}{-0.25}zdz+\int_{0.625}^{0.75}\frac{(z-0.5)}{0.25}zdz+\int_{0.75}^{0.875}\frac{(z-1)}{-0.25}zdz+\int_{0.875}^{1}\frac{(z-0.75)}{0.25}zdz}{\int_{0.25}^{0}\frac{(z-0.25)}{0.25}dz+\int_{0.5}^{0.625}\frac{(z-0.75)}{-0.25}dz+\int_{0.625}^{0.75}\frac{(z-0.5)}{0.25}dz+\int_{0.75}^{0.875}\frac{(z-1)}{-0.25}dz+\int_{0.875}^{1}\frac{(z-0.75)}{0.25}zdz}$$

$$= 0.67 \qquad (2)$$

Finally, the WMS matrix is calculated and given in Table III.

D. Drawing the FCM

The FCM of supporting factors for information sharing to success CPFR implementation in retail sector is given in Fig. 4.

IV. Dynamical behavior

Various "what-if" scenarios can be practiced after inserting the necessary information to the simulation program. Because of the page limitation, only one scenario is given to show the usefulness of the approach. We searched 41 concepts of the information sharing sub-system model and the causal relationships that exist among these concepts.

In our scenario, we investigate the case where the "managers' unwillingness to share information" is high. We set the activation level of this factor to 0.1 and we see the considerable effect on the other concepts. The results are given in Table V. The dynamical behavior of the system is represented in Fig. 5.

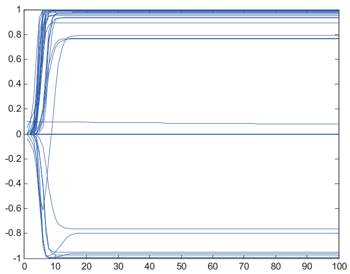

Figure 5. The dynamical behavior of scenario

After investigating the scenario, the factors and the changes are given in Table IV

VI. Conclusion

Many firms recognize the supply chain efficiencies and competitive advantage to be gained by implementing CPFR. Research shows that the adoption and utilization of CPFR in supply chain are limited and inefficient. Given the impact and benefits of CPFR, it is essential to ensure their successful implementation and adoption by supply chain partners. The aim of this study has been to provide a rich insight into context of CPFR success in supply chain.

In order to do this, we have used the FCM approach to model the supporting factors for CPFR. The FCM approach has allowed us to identify and model both qualitative and quantitative factors and their complex causal relationships in the context of successful CPFR adoption, based on the perceptions of industrial experts.

Communication is found to be the most crucial factor, beside of its risks. They should trust in each other and business plans, forecasts, promotion plans should be shared. The sustainability of communication is valuable. Different from the communication capability, system complexity, trust among SC members, system security, good ICT infrastructure, like EDI, willingness of managers are also necessary for success CPFR implementation in retail sector. Cross department support increases intention to information sharing. This also helps improving the information quality and may provide effective decision making. It is considered that the key supporting factors for CPFR implementation in retail sector are such as cross department support, continuous information sharing, partner communication and trust and willingness of managers.

For the perspective of this study, the proposed models and developed approach could be implemented in other sectors. In this way, sector differences could be identified and the requirements for more effective CPFR structures could be emphasized.

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Table II. The IMS of information sharing sub-system via expert 1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Z	Z	PVS	Z	PS	PS	Z	Z	Z	Z	PM	Z	PS	Z	Z	PS	Z	Z	Z	PS	PVS	PS	PM	PVS	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
2	Z	Z	PVS	Z	Z	Z	Z	PVS	NS	Z	Z	Z	PVS	Z	Z	Z	PM	PS	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
3	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PM	PS	NM	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
4	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NW	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
5	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PS	Z	Z
6	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
7	Z	Z	NVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NM	Z	Z	Z	Z	NS	Z	Z	Z	Z	Z	Z	PM	Z	Z	Z	Z
8	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
9	Z	NVS	NVS	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NM	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
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11	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z
12	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PS	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	NS	Z	Z	Z	Z
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16	PW	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
17	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
18	Z	Z	PM	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
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21	Z	Z	PS	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z
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29	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PS	Z	Z	Z	Z	PVS	Z
30	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
31	Z	Z	NM	Z	Z	Z	Z	Z	NW	Z	Z	Z	Z	Z	Z	NVS	Z	Z	Z	Z	NS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
32	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
33	Z	Z	Z	Z	Z	Z	Z	Z	NW	Z	Z	Z	Z	Z	Z	Z	PM	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
34	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
35	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z
36	Z	Z	Z	Z	PM	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NVS	Z
37	Z	Z	NS	Z	NM	Z	Z	Z	Z	Z	Z	NS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
38	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NW	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
39	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
40	Z	Z	Z	Z	Z	Z	PS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	NM
41	Z	PVS	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z

Table III. The WMS of information sharing sub-system in retail sector

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
1	0	0	0.79	0	0.79	0.79	0	0	0	0	0.25	0	0.75	0	0	0.75	0	0	0	0.79	0.92	0.79	0.375	0.92	0	0	0	0	0	0.79	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0.92	0	0	0	0	0.92	-0.79	0	0	0	0.92	0	0	0	0.5	0.75	0	0	0	0.625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.67	0.79	--0.625	0.92	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0.75	0	0
6	0	0	0	0	0.625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	-0.92	0	0	0	0	0	0	0	0	0	0	-0.92	0	0	0	0	0	0	0	0	0	0	-0.25	0	0	0	0	--0.625	0	0	0	0	0	0	0.5	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	-0.92	-0.92	0	0	0	0.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0.5	0	0	0	0	0	-0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0.75	0	0
11	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0
12	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0.92	0	0	0	0	0	0	0	0	-0.75	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	-0.92	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0
14	0	0.79	0.75	-0.25	0.75	0	0	0	-0.92	0	0	0	0	0	0	0	0	0.5	0	0	0.375	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0	0
16	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0.79	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0	0	0	0	0	0	0
22	0	0	0.5	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0.79	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0.375	0.25	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.67	0	0	0	0	0	0	0	0.375	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0.92	0.92	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0	0	0	0	0	-0.92	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0	0	0.79	0
30	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	-0.25	0	-0.125	0	0	0	-0.125	0	0.125	0	0	0	0	-0.79	0	0	0	0	-0.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	-0.375	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0
36	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.92	0
37	0	0	-0.75	0	-0.5	0	0	0	0	0	0	-0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0.75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.5
41	0	0.92	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

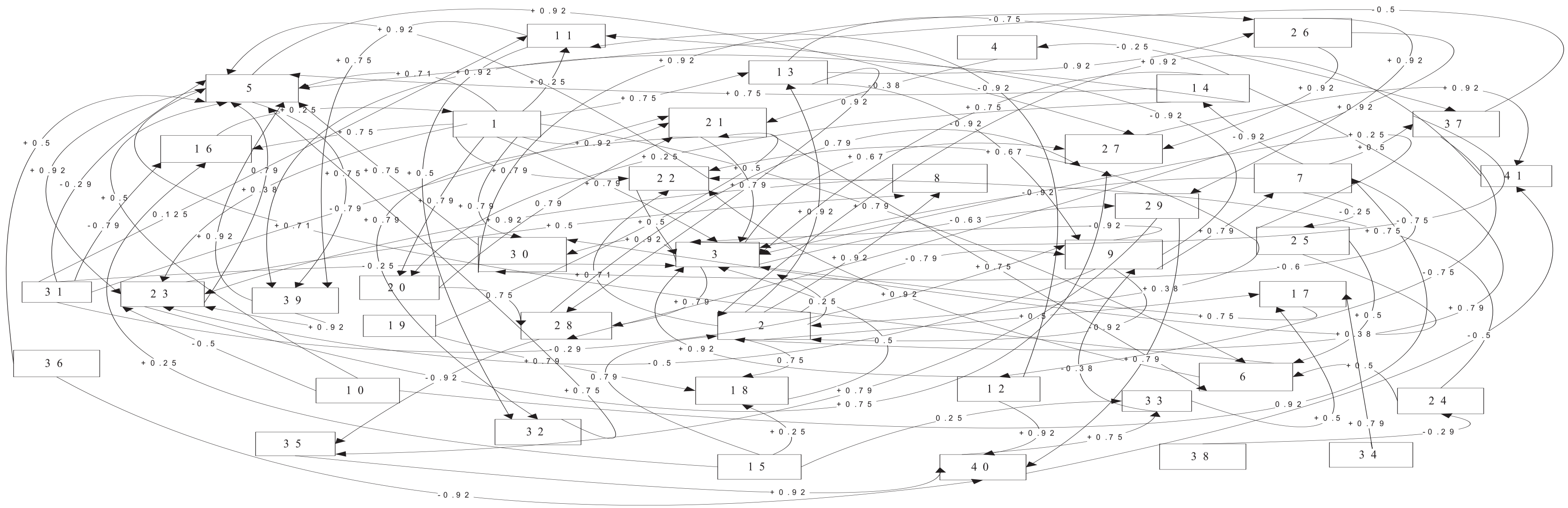

Figure 4. The FCM of information sharing sub-system in retail sector.

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Table VI. The interpreting table of scenario

In this table, two arrows represents that when a slight positive change in "unwillingness of managers to share information occurred, these factors are affected strongly than the factors represented just one arrow.

Differences in technologies and systems employed by partners	–	Continuous information sharing	↗↗	Effective database linkages	↗↗	Cross department support	↗↗
Good ICT infrastructure, like EDI	–	Regularly scheduled meetings	↗↗	Increased of the bullwhip effect	↗↗	Lower employee involvement	↘↘
System compatibility	–	Intensity of communication	↗↗	Timely and relevant information	↗↗	Information sharing cost	↘↘
Effectiveness of partner selection	–	Information transparency	↗↗	Incentive alignment	↗↗	Firms' technological capacity	–
Organizational readiness	↗↗	Clearly and identified broad communication channels	–	Intensive information	↗↗	Information reliability	↗↗
Culture of openness and honesty	–	Openness of communication	↗↗	Unwillingness of manager to share information	↘↘	Increased in organizational size	–
Personnel trainee	↗↗	Clarity about demand	↗↗	Partner communication	↗↗	Integration of systems	↗↗
The leakage of information sharing	↘↘	Increased inventory	↘	System security	↗↗	Information quality	↗↗
Trust among SC members	↗↗	Improved business performance	↗↗	Level of SC/logistics integration	–	Heterogeneity and hostility of industrial environment	↘
Trading partner's readiness	↗↗	Effectiveness of decision making to plan and control SC operations	–	Trading partners technical readiness	–	Accurate forecasts	↗↗

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