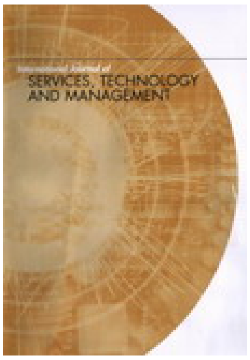

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Predicting a model of agile supply chain in the service provider enterprises by factor analysis method and fuzzy cognitive map

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Abstract: Organisations nowadays face high competition and turbulent environments, which have been intensified due to technology innovations and changing needs of the customers. In such circumstances, the fastest way to adapt is being agile. The service provider organisations are not excluded from this rule. In this paper, with the purpose of predicting a conceptual model of the agile supply chain in the service provider enterprises, an extensive study was conducted in the literature and the factors affecting agility of the supply chain in the service provider organisations are identified. Then, the importance of each factor is examined through 100 questionnaires completed by experts in the Iranian service providing enterprises. The 11 critical success factors were derived from the exploratory factor analysis technique and finally, the causal relationships among these factors is studied by fuzzy cognitive mapping method and the conceptual model is explored. This model can help service provider managers to make appropriate decisions based on the causal relationships between the critical success factors of agile supply chains to respond more rapidly than their market competitors to the environmental turbulence.

Keywords: agility; service supply chain management; SSCM; fuzzy cognitive mapping; FCM; critical success factors; CSFs; service provider enterprise.

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1 Introduction

Supply chain management (SCM) is important as one of the production paradigms of the 21st century to improve organisational competitiveness. SCM has faced some challenges such as creation of trust and cooperation among partners of the supply chain, determination of the best actions which can facilitate alignment and integration of supply chain process, successful implementation of information technologies and utilisation of internet as factors of efficiency, performance and quality in supply chains (Yusuf et al., 2004; Cooper et al., 1997).

On the other hand, turbulent and volatile markets are becoming the norm as life cycles shorten and global economics and competition forces create additional uncertainty (Sherehiy et al., 2007). Lack of incremental confidence and dynamicity in markets, reduction of lifecycle of the products besides rapid transformation in customers' needs and technological innovation force the companies to adapt to these environmental changes of the market to survive (Christopher and Towill, 2002; Fekri et al., 2009). In these challenging conditions, companies should response more rapidly than their rivals to this environmental turbulence. This concept named agility. The importance of an agile supply chain becomes more evident when a supply chain reacts to the market changes rapidly and effectively. The agile supply chains not only can show a reaction to ordinary changes but also respond properly to the unexpected changes required by the market which is first felt. Therefore, there is a belief that agility is the required characteristic for the future competitive pressures of organisations and competitive advantages (Yusuf and Gunasekaran, 1999). Agility in supply chain causes ability of the supply chain (as a whole) and its members for rapid alignment in a network with dynamicity and fluctuations in the requirements of customers (Ismail and Sharifi, 2006).

In all the definitions of agility, four main dimensions of it, including enriching the customers, cooperation to enhance competitiveness, leveraging the impact of people and information and organising to master changes are regarded as the essential principles (Metes et al., 1998).

Despite the differences between goods and services and consequently, differences of the supply chain of these two cases, the requirements of the service supply chain (SSC) to be agile cannot be denied, so a service organisation needs that all of its chain components as the production supply chains become agile. Agility is directly effective on the ability of a service provider organisation to produce and deliver new services with logical cost (Sherehiy et al., 2007).

Although using agility concept and extracting the agile SCM model have been considered in the manufacturing processes, identifying the main factors of the agile service supply chain management (ASSCM) and investigating the causal relationships between them has not been considered very much.

The literature review illustrates that there are many types of research investigate the agile supply chains in the production sector (Christopher and Towill, 2002; Sharifi and Zhang, 1999; Goldman et al., 1995; Christopher, 2000; Vazquez et al., 2007; Tseng and Lin, 2011; Xirogiannis et al., 2004; Kang et al., 2004), but because of the main differences between the production and service concept, such as intangibility, the heterogeneity between the entries, the high interface between the customers with the service process, the lower need to storage ,and the different method of delivery and productivity evaluation of service organisations in compare with a manufacturing company, proposing a conceptual model which show the relationships between the main factors of the ASSCM is a must.

The main objectives of this paper are as follows: extracting the main factors affecting the ASSCM and finding the causal relationships between them in Iranian service provider enterprises. To extract the main factors of ASSCM, first we study the literature to find the main dimensions of agility and service SCM, and then the variables of the ASSCM are extracted through affecting agility dimensions on each of the stages of the service supply chain. Then the importance of each factor is examined through 100 questionnaires distributed among the experts in the Iranian service providing enterprises. The 11 critical success factors (CSFs) were derived with the exploratory factor analysis technique and finally the causal relations among these factors is studied by fuzzy cognitive mapping (FCM) method constructed with the Distance-based algorithm and the conceptual model is explored.

This paper is organised as follows: In Section 2, the concept and the literature of agility, also service SCM is reviewed and the CSFs of agile service SCM are identified. In Section 3, the research methodology is presented in two sections. In the first section, the CSFs of agile service supply chain are introduced based on the explanatory factor analysis in Iranian service sector. In Section 2, the FCM technique is used to show the cause and effect relationship between these CSFs and an FCM model of agile SSCM is extracted. In Section 4, some managerial implications resulted from the FCM model for service supply chain practitioners are mentioned. In the last section, the conclusion and some suggestions for future studies are presented.

2 Literature review

Services have grown considerably in recent years so that its share from gross global production is higher than other sections and has led to transfer of economy from industrialism to service orientation. Based on the reports of the World Bank in 2019, service sectors' income share is more than 55% of the gross domestic productivity (GDP) in developing economics (Nayyar et al., 2021).

For these reasons, strategies such as the provision of high quality services have attracted the highest attention in competitive and free markets (Raajpoot, 2004). But what is the exact meaning of services? Any economic and nonphysical commodity which a person, an agency or an enterprise produces, to be used by others and is invisible and intangible, is regarded as service that is consumed at the same time of production and creates value added intangibly in different forms (such as comfort, amusement, welfare, etc.). In the other words, service is the intangible event or process which is created and used concurrently. Despite similarities, there are main differences between goods and services as follows (Arbos, 2002):

- Goods are tangible and storable but services are not tangible and storable.
- In the production process, goods and its operations can be controlled and confirmed but services have no exact objective index and a service which is suitable for a person may not be regarded suitable by another person.
- Service can be concurrent with the service operation and even customer can participate in it, but goods are generally produced and customers confront with it after completion of production and receipt of goods.
- Unlike goods, there is no clear standard for services because their changeability is much higher than production.
- It is not possible to adjust reference time of a customer in service provider organisations while the delivery time of goods is predefined.
- The heterogeneity of the customers' skill is effective in receipt of services, for example, the service received by an ordinary person is different from the service received by a person who is aware of medicine in referring to a physician.
- The responsibility of the customers in service provider systems can reduce costs, for example, if they return the shopping cart of the chain stores to the specified parking, the service provider does not need to hire someone to do that.
- In services, the customers obtain its advantages but they do not own a physical element.

Manwani and Carr (2011) believe that the organisations require effective management of services to achieve the desirable level and reduce cost with information systems. The results of their research show that three factors are affecting the supply chain speed in the service provider organisations including flexible and multi-skill people, processes and technology (Manwani and Carr, 2011).

A supply chain includes suppliers, distributors, manufacturers, and customers who are connected to each other through feed-forward and up-stream flow. As Christopher (2000) said, the supply chain is a network of organisations which are involved in different processes and activities which create value as products and services to the end user. He believes that the effective solution for reaching cost benefit is not the volume of the products and economic scale but is the management of supply chain. A manufacturing supply chain consists of all the activities relating to transfer of goods from raw materials to the end user which include sourcing and supply, production scheduling, order processing, inventory management, transfer, warehousing and customer services. It also includes the required information systems for supervision and coordination of activities (Yusuf et al., 2004).

A service SCM is concerned with the planning and management of activities from support functions to the delivery of end-user services (Voudouris et al., 2008). The terms of *services-oriented SCM* (Anderson and Morrice, 2000), *service management* (Fitzsimmons and Fitzsimmons, 2001), and *service chain management* (Voudouris et al., 2008) have been used in the service supply chain studies. To achieve the end customer's satisfaction, each of the different tasks in the network of SSC should be integrated and coordinated systematically (Cayama, 2008). As Sakhuja and Jain (2012) described there are two main characteristics in SSC: The first one is that "the different service providers manage the business service processes which is decomposable into several sequential tasks, and the second one is the main capacity resource in SSC is skilled labor, and there is no inventory and material flow in it."

On the other hand, studying the researches about the SSC shows that few researchers have been interested in the management of supply chain processes of services (Boon-Itt et al., 2017; Aitken et al., 2016; Sengupta et al., 2006; Baltacioglu et al., 2007; Ellram et al., 2007; Breidbach et al., 2015; Wang et al., 2015). Some of these studies focused on the definitions and traditional aspects and characteristics in the service supply chain functions (Kathawala and Abdou, 2003; Ellram et al., 2004) while the others focused on the investigation of the service provider and the end consumer of a service relationship management (Sampson and Froehle, 2006).

In an attempt to develop a service SCM framework, six processes of the SSCM have been introduced. These processes are: skills and capacity management, supplier relationship management (SRM), demand management, customer relationship management (CRM), service delivery management, information flow and cash flow (Ellram et al., 2004).

Cho and Lee (2012) have identified the supply chain processes of services in their study and then provide a framework based on analytical hierarchy process for evaluation of the performance of service provider supply chain. In their research, demand, capacity and resources management, customer relation management, SRM, orders process management, service performance management, technology and information management of the processes were identified as the main stages of SSCM. Ballou et al. (2000) also, introduced order process management as one of the main processes should be considered in the service SCM. The descriptions of these dimensions are as follows:

- *Demand management*: There are some variations in demand through the SSC could effect on the capacity and productivity of the service supply chain due to the less flexibility and inability to store services. Demand management is used to manage the demand variations by generating and investigating the customer demand and its uncertainties. The service provider manager should monitor, reduce and omit the demand variations by managing the capacity of work, time, productivity and commitment by some controlling policies and techniques such as selling additional services, also by additional work through hiring staff and overtime (Ellram et al., 2007).
- *Capacity and skills management*: All the investment in the service organisation such as processes, staff and assets should be controlled and managed in the SSC like a manufacturing supply chain for goods. Service provider managers can control the availability and quality of capacity and skills in order to reduce the problems in the different sectors of service supply chains (Bitner, 1995).
- *CRM*: Recognising the customer requirements and concentrating on meeting and fulfilling them to satisfy the customers is a necessity especially in the service provider organisations (Bitner, 1995). To achieve this goal, making research on the customer requirements in markets and monitoring the level of their satisfaction, also investigating their changing desires are essential (Zeithaml and Bitner, 2003). Integrating the CRM with SSC can improve the level of trust and communications in the performance of an SSC (Wisner, 2003).

- *SRM*: After identifying the customer needs, recognising the potential suppliers, selecting the qualified ones and purchasing goods and procuring professional services from them should be managed. Contract management, qualified negotiations and the commitment of execution of the clear service level agreements (SLAs), could reduce the uncertainties and ensure the suppliers' performance as one the most important process of the SSCM (Ellram et al., 2007).
- *Order process management*: Order process management is included the functions of receiving the orders from customers, tracking the orders by making the appropriate communications with them in the necessary occasions, fulfilling their orders and ensuring from receiving the orders by them (Lambert et al. 1998). This process could be accomplished through order receiving, preparation, transmittal, entry, and filling and order status reporting (Ballou et al., 2000) and has many intersections with other functions of SCM. Thus, it has a great impact on customer's perception of service and customer satisfaction which are decisive and shared aims of the firms in a service supply chain.
- *Service performance management*: In the most of the service businesses, the customer and the service provider are in the same place and the consumption occurs simultaneously, so the performance management in an SSC is more essential than SCM. This process has some sub processes like monitoring, analysing and reporting to ensure that each of the sectors in the service supply chain performance is accomplished as correctly as it is planned (Baltacioglu et al., 2007).
- *Information and technology management*: Information technology is a useful tool in the supply chain to integrate all the sectors and coordinate all the processes in the SSC. Managing the information flow is a necessity could improve the level of SSC performance, accuracy, availability, flexibility, on time delivery, efficiency and responsiveness, also reduces the delays and disorders in the service chain operations (Korhonen et al., 1998).

On the other hand , rapid growth of technology, risk-taking and increasing rate of unpredictable and constant changes in markets have led the organisations to face intensifying pressure for reduction of production and service cycle along with reduction of development costs, protection of desirable and rapid innovation and considering philosophy of earlier, better and cheaper production of goods and services. For these reasons, as mentioned before application of agile strategies is an essential, main and effective factor. Agility means the rapid ability of the organisation to fulfil needs of customers by providing a new product in terms of quantity and quality. In fact, in an agile process, technology, management and people of the organisation interact with target-oriented, efficient and planned method in a dynamic and changing environment in terms of unpredictable changes and for rapid response to these changes (Sharifi and Zhang, 1999, 2001). In another definition, Sharifi and Zhang (1999) defined agility of the organisation as the ability to encounter with unexpected challenges for overcoming the new and unexpected threats of the business environment and acquisition of changes advantages as opportunities. Goldman et al. (1995) also described an agile organisation as dynamicity and having the potential to achieve competitive advantage, dynamicity for the competitive strategy of an organisation, focus on the development of knowledge and flexibility of processes with an ability to respond to changes of such conditions for the organisation.

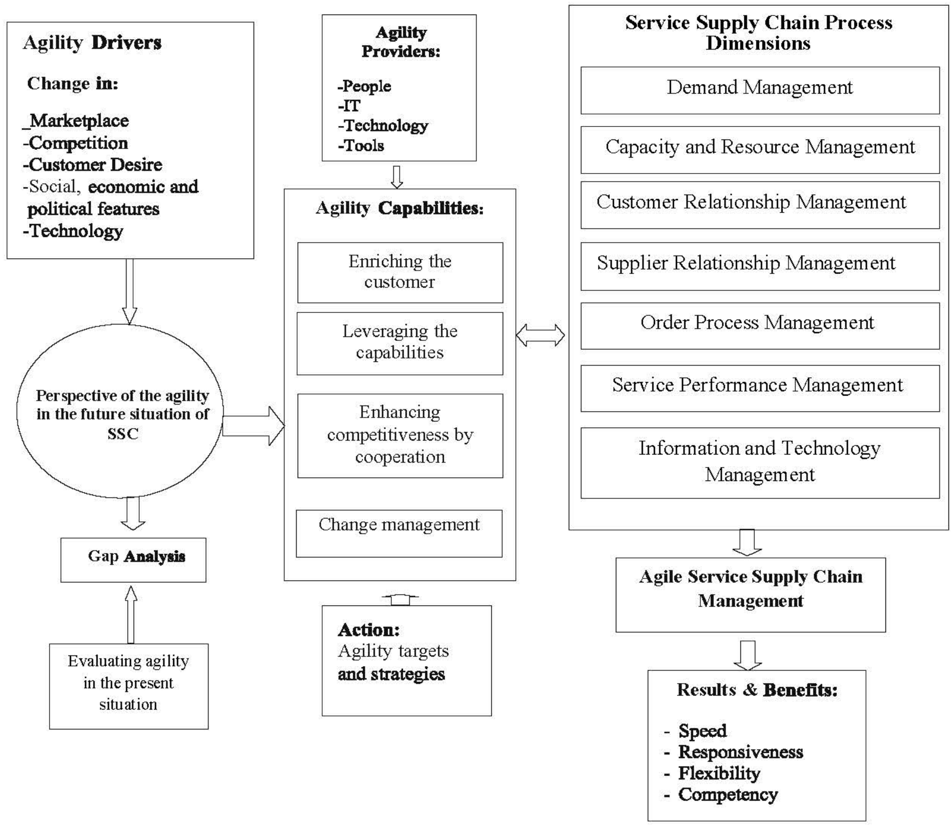
Tseng and Lin (2011) classified the drivers of agility, factors of agility and abilities. Drivers of agility indicate the changes which are permanently available in the commercial environment of the organisations and stimulate and force the organisation to be agile. Factors of agility are the organisational factors which are regarded as the infrastructure of agility in the organisations and abilities of agility are the factors which measure the agility level of the organisation. In another research done by Gligor et al. (2015), it has been revealed that there is a strong relationship between firm's agile supply chain and achieving customer-related objectives, also financial benefits through constructing a structural equation modelling approach.

Some models have been presented by the researchers for the agile supply chain in the manufacturing sector (Sharifi and Zhang, 1999; Goldman et al., 1995; Christopher, 2000; Vazquez et al., 2007; Van Hoek et al., 2001). The results of a study done on 197 Malaysian SMEs in manufacturing-related services sector revealed that entrepreneurial orientation (EO), participative management style, supplier relations, resource management, just-in-time (JIT) positively influence ASSCM while participative management style is not a predictor toward an effective ASCM (Malakouti et al., 2017).

Although service SCM saw considerable growth in the propagation of theories and actions in the past decades and as mentioned before, some studies have been conducted on different aspects of it, using the agility concept in the service supply chain has not attracted enough attention of researchers and professionals. It seems that the results of researches conducted on the agile manufacturing SCM can be used in the supply chain of service provider organisations but the fact is that the framework of service supply chain is different from the SCM in the manufacturing organisations. The differences between goods and services which were mentioned before cause the difference between the factors affecting the performance of agile supply chain in the service provider organisations and the manufacturing organisations. This matter is the main root of formation of the current research. This paper tries to identify the CSFs affecting the agility of supply chain in the service provider organisations and illustrate the causal relations between these factors in an FCM conceptual model. Figure 1 illustrates a diagram of using agility dimensions in the service supply chain process.

Three main parts can be seen in this figure. These parts are agility drivers, agility capabilities and agility providers (Sharifi and Zhang, 1999). Changes in the different parts of the supply chain such as the changes in customer desires and markets, behaviours of competitors, knowledge and technology improvements, social, economic and political change are the operators; act as the agility drivers in the supply chains both in the manufacturing and service supply chains. There are also agility providers in the model which are applied as useful enablers to make the supply chain as agile as possible. These providers are people, tools, IT and technology. On the other hand, four dimensions of agility are 'enriching the customers', 'leveraging the capabilities', 'enhancing competitiveness by cooperation', and 'change management'. These main dimensions recognised as the agility capabilities that strengthen the managers to respond to the unanticipated changes before the competitors and as quickly as possible (Metes et al., 1998). The figure finally shows that results of applying the agility concept in the SSC are some valuable achievements which are flexibility, competency, speed and responsiveness.

Figure 1 A diagram of using agility concept in the processes of service SCM



3 Research methodology

The present research has been conducted to identify a model for agile SCM in the Iranian service provider organisations .The main factors of the agile service supply chain were identified by using the agility dimensions in each of the dimensions of service SCM process as illustrated in Figure 1. So, 45 variables of agile SSCM are extracted which are illustrated in Table 1. The designed questionnaire has 45 questions of five-point Likert scale and the effects of the identified variables were enquired in each question of the questionnaire. Choice 1 means fully unimportant while 5 means fully important. Respondents have selected a suitable choice from fully unimportant to fully important. This questionnaire was first studied in terms of face and content validity and then ten initial samples were distributed among the Iranian managers of service provider enterprises and the potential ambiguities were studied and removed.

The unlimited population sampling formula (Cochrane formula) was used and its result manifested the necessity of sampling 96 samples. We know that the sample size should be at least twice as much as the number of the questions which is near to the number calculated from Cochrane formula. So, 130 questionnaires were distributed and 100 completed ones were used in our analysis.

Table 1 The effective variables of the service supply chain agility in Iranian service provider enterprises

No.	*Variable*	*p-value*
1	Improving financial criteria's as ROI and cash flow …	0.000
2	Minimising inventories and applying economic order quantity (EOQ)	0.229
3	Developing staff skills and hiring flexible and qualified staff	0.000
4	Interaction with customer during providing the service and receive feedback	0.000
5	Implementing suggestion system for personnel as one who is in touch with customer	0.000
6	Accurate forecast methods and suitable planning	0.000
7	Efficiency of service distribution scheduling	0.000
8	Minimising the time between receiving and delivery of the order	0.000
9	Maximum usage of the capacity to provide service	0.000
10	Minimising the time to develop new services and using benchmarking methods in this process	0.003
11	Innovation and investment in new services and R&D and market test	0.001
12	Concurrent engineering and taking care of customer needs in design of services	0.001
13	Forecasting market changes to find right time for new services	0.000
14	Diversification and flexibility in service providing	0.000
15	Service reliability	0.000
16	Custom built services	0.000
17	Improving quality and implementing quality circles	0.000
18	Checking out customer satisfaction and acceptance in the market	0.001
19	Qualitative ability of suppliers and their technical support	0.000
20	Strategic partnership with customer or supplier and being in touch with suitable number of suppliers	0.050
21	Increasing interaction with suppliers and customers to develop the appropriate strategy	0.047
22	Identifying pricing payment and delivery method	0.050
23	Developing the ways to refer customer complaint especially electronic ways (phone, e-mail)	0.127
24	Collecting a rich database of potential suppliers to be able to choose and replace	0.000
25	Using IT infrastructure and data sharing in the whole chain to get the best strategy	0.000
26	Developing e-sale and e-payment	0.000
27	Quality and the speed of investigation to the complaint	0.000
28	Quality of documentation and data record of demand and delivery	0.004
29	Technologic fitness and updated equipment	0.000
30	Outsourcing	0.993
31	Maximising supply rate (orders that are done)	0.000
32	Synergy and integrating into supply chain of service supply chain	0.000

Table 1 The effective variables of the service supply chain agility in Iranian service provider enterprises (continued)

No.	*Variable*	*p-value*
33	After sale services for the services	0.000
34	Revising and merging the processes	0.016
35	Customer base strategy instead of profit base	0.000
36	Top management commitment to innovative strategies and risking	0.001
37	Organising multiple objective teams for decision making	0.000
38	Focusing on adding value opportunities for customers	0.207
39	Continuous monitoring of strategies of service supply chain and developing interactive and dynamic strategies	0.000
40	Identifying market opportunities and sensitiveness to market demand	0.000
41	Data gathering about the competitors and their services(products)	0.000
42	Selecting customer base ideas according to historical data	0.000
43	Selecting ideas according to world-class standards	0.006
44	Implementing ERP to overcome on barrier(structural, cost, geographical)	0.007
45	Emphasising on stakeholder goals	0.047

The characteristics of the enterprises their supply chain managers were involved in data gathering are shown in Table 2. In this research, the uncompleted data were regarded as the eliminated data.

Table 2 The respondents' information

Service industry type	*Quantity/percentage*
Training	12
IT and software	12
Consultants	12
Quality control and inspection	7
Commerce and logistics	14
Finance and audit	9
After sale services	7
Planning and project control	8
Engineering R&D	12
Single service providers	9
Total	100

To test the reliability of the questionnaire, the index of Cronbach's alpha was used. Alpha value was obtained 0.95. Before factor analysis, the adequacy of the sampling should also be assured.

For this purpose, we used Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. KMO index studies small partial correlation and specifies if the variance of the research variables is affected by the common variance of some hidden and main factors. This index is between 0 and 1 and if the data are closer to 1(at least 0.6) the desired data is suitable for factor analysis; otherwise, the results of the factor analysis are not valid. In Bartlett's test of sphericity, null hypothesis mentions that a correlation matrix is a unit and the elementary matrix and in this case, it will be unsuitable for identification of the structure (factor model). If sig of Bartlett's test of sphericity is smaller than 5%, factor analysis will be suitable for identification of the structure.

The value of 0.752 for KMO and significance degree of lower than 0.05.It indicates acceptable correlation degree between the variables for explanatory analysis of factors which are shown in Table 3.

Table 3 The results of KMO and Bartlett' test of sphericity

Kaiser-Meyer-Olkin measure of sampling adequacy	0.752
Bartlett's test of sphericity	2,130.335
Degree of freedom	820
Significant level	0.000

To determine the factors affecting the agility of the supply chain of the service provider organisations, statistical analysis of the t-test was done as you see in the second column of Table 1; factors 2, 23, 30 and 38 have p-values of more than 0.05. Therefore, they are not recognised as the important and effective factors of agile SSSM in Iranian service provider industries. These 41 significant variables were used in the exploratory factor analysis process. The data analysis for 41 identified factors was done with factor analysis method and varimax rotation by using SPSS 19. Eleven CSFs of ASSM were suggested and the total explained variance is 71.7% as shown in Table 4.

Table 4 Factors analysis results

Factor		*Eigenvalue*	*% variance*	*Cumulative variance*	*Related variables*
1	Integrating supply chain components	13.566	33.1	33.1	7, 17, 19, 20, 21, 25, 29, 39
2	Upgrading quality and flexible services	2.545	6.2	39.3	4, 15, 16, 18, 27
3	Market sensitivity and responsiveness	2.017	4.9	44.2	40, 41, 42, 45
4	Customer oriented design and development of services	1.842	4.5	48.7	11, 12, 13, 14
5	Human skills and customer satisfaction development	1.739	4.2	52.9	3, 5, 28, 33, 43
6	Innovative strategy and solving strategic problems	1.591	3.9	56.8	34, 36, 37
7	Developing the services	1.454	3.5	60.4	31, 44
8	Dynamic and flexible planning	1.279	3.1	63.5	6, 8, 9, 10
9	Concerning to the market and organisation financial situation	1.218	3.0	66.5	1, 22
10	Using IT infrastructure	1.121	2.7	69.2	26, 32, 35
11	Updating competitors and suppliers data	1.039	2.5	71.7	24

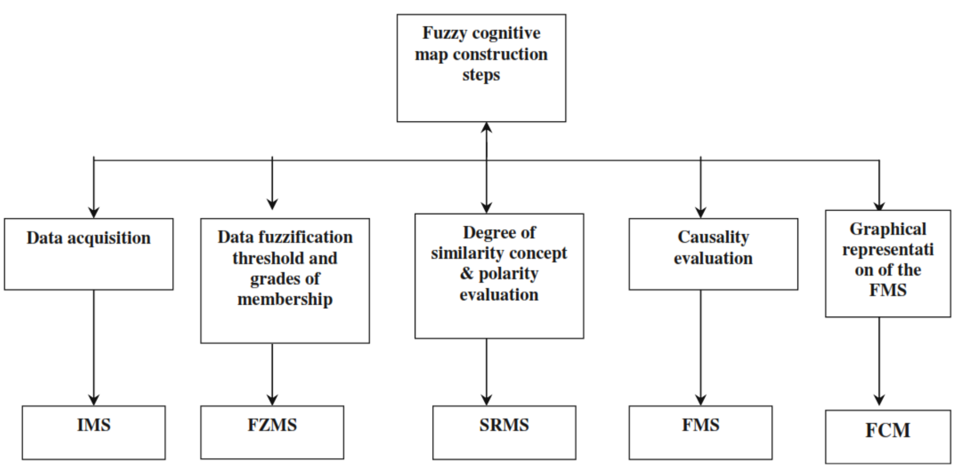
Factor loading square of the variables is the percentage of variance of that variable which is explained by that factor. The higher factor loading of variables of each factor indicates higher convergent validity and mentions the validity of the obtained model (Sharma, 1996).

After identifying the CSFs on the agility of supply chain in the Iranian service provider enterprises, it's the time to check the causal relationship among these factors and see how they effect on each other. To do so, we intend to use FCM. The graphical illustration of an FCM is consisted of the nodes of concepts that correspond to the variables or factors and also the weighted arcs with the signs. These arcs show the relationships between the nodes. The weight number on each arc is in the interval of [–1, 1] illustrates the amount of effect of one node on another, while the sign represents that the first node has positive or negative effect on the second one. It means that the high number value of a weight show the strong effect and the low value number shows the weak effect of a node on the other one. As mentioned before, because of the number of different factors of ASSCM and complicated relationships between them, we use the FCM technique based on the distance-based algorithm. This technique was applied by Schneider et al. in 1998 for the first time.

In designing an FCM model based on the distance- base algorithm technique, a cognition model is constructed based on the experts' opinion about the importance of a concept. It means that the nodes and the relationships between them are designed based on the experts 'experience and knowledge about a concept.

As Schneider and their colleagues in 1998 mentioned, the distance-based algorithm technique which is used in FCM construction has five main steps. In the first four steps, four matrices are applied and in the fifth step, the final model is illustrated. These matrices are shown in Figure 2. As it can be seen in this figure the first matrix named initial matrix of success (IMS), the second one is fuzzified matrix of success (FZMS), strength of relationship matrix of success (SRMS) and the final matrix of success (FMS) are the third and fourth matrices used in constructing the FCM.

Figure 2 The steps of constructing an FCM model by using distance-based algorithm technique



Source: Schneider et al. (1998)

As mentioned before, 11 CSFs of agile SSCM in Iranian service organisations are extracted by applying explanatory factor analysis method. These factors mentioned in Table 4. To reveal the causal relationships between these CSFs as explained earlier the FCM method is used. This FCM is constructed based on the distance-based algorithm.

Step 1 Based on the first step of the procedures of FCM construction in the Figure 2, 100 experts included of the managers, consultants, and executors of the supply chain in the Iranian service providers which have been successful in the execution of agile SSCM are interviewed and ask them to evaluate the importance of each of the 11 CSFs on the agile SSCM based on their knowledge and experience. These experts are chosen from the different service enterprises which mentioned in Table 2.

The data gathered from the interviews are in the scale from 0 to 100. Zero means that the element does not have any importance on the agility of SSCM in Iranian service provider sector while 100 mean that the factor has the maximum effect on agile SSCM. These elements are illustrated in the IMS matrix as the first matrix of FCM with 11 rows and 100 columns. The rows are the number of factors while the columns are the experts were interviewed. Table 5 in Appendix shows this matrix.

Step 2 After gathering data about the importance of each factor from the experts' view and show them in the IMS, now it is the time that each of the numerical vectors of the 11 elements converted into the fuzzy numbers. The matrix illustrated the membership of each component of the vector named FZMS. Each element of this matrix represents the degree of membership of the component O_{ij} of vector V_i to the own vector V. To transform the numerical vectors into fuzzy sets with values in the interval [0, 1] these following steps are required to perform:

- The maximum value in V_i should be considered and $X = 1$ and assigned to it. That is

$$\max\left(O_{ij}\right) \rightarrow X_i\left(O_{ij}\right) = 1 \tag{1}$$

- The minimum in V_i value should be considered and $X = 0$ assigned to it. That is

$$\min\left(O_{ij}\right) \rightarrow X_i\left(O_{ij}\right) = 0. \tag{2}$$

- All the elements of vector V should be projected to the interval [0, 1] by using equation (3):

$$X_i\left(O_{ij}\right) = \frac{O_{ij} - Min\left(O_{ij}\right)}{Max\left(O_{ij}\right) - Min\left(O_{ij}\right)} \tag{3}$$

In some cases, directly projecting vector into the interval [0, 1] may generate the grades of membership which are different from the real amounts, so the upper and/or lower threshold should be considered. As mentioned earlier V is the numerical vector of the elements associated to the concept 'i' and O_i, with $j = 1, \ldots, m$, equation (4) shows the mathematical values of the upper and lower threshold (α_u, α_l respectively) as follows (Schneider et al., 1998):

$$V_j = 1, ..., m \quad O_{ij}\left(O_{ij} \geq \alpha_u\right) \Rightarrow X_i\left(O_{ij}\right) = 1$$
$$V_j = 1, ..., m \quad O_{ij}\left(O_{ij} \leq \alpha_e\right) \Rightarrow X_i\left(O_{ij}\right) = 0 \tag{4}$$

In this paper, based on the experts' opinions, the amount of alpha is considered 20%. Therefore, the upper and lower threshold values are 80 and 20. Table 6 in Appendix shows the FZMS matrix included the X_i (O_{ij}) as the degree of membership of the opinion of individual *j* related to factor *i* to the whole vector.

Step 3 The strength of the relationships between the variables should be estimated in this stage. This strength shows the degree of similarity between two variables and is evaluated by a fuzzy weight provided by a positive or negative sign. Positive sign indicates the direct relationship while the negative sign shows the inverse relationship between them. The SRMS matrix shows these assumptions. This matrix is has 11 rows and 11columns. Both the rows and columns of his matrix are the CSFs and each element Sin in the matrix indicates the relationship between factor i and factor *j*. As mentioned earlier the similarity between these two vectors is assumed by the strength of relationship between them (Schneider et al., 1998).

Equation (5) is applied in the case of the direct relationship between V_1 and V_2 that means any increase in the amount of V_1 leads to an increase in the amount of V_2, and the closest relationship between them is assumed as follow for each *j* ($j = 1, \ldots, m$)

$$X_1\left(V_j\right) = X_2\left(V_j\right) \tag{5}$$

The d_j as the distance between the corresponding j^{th} elements V_1 and V_2 assumed based on equation (6).

$$dj = \left|X_1\left(V_j\right) - X_2\left(V_j\right)\right| \tag{6}$$

And the average distance between V_1 and V_2 called *AD* and is assumed based on equation (7).

$$AD = \frac{\sum_{j=1}^{m} \left|d_j\right|}{m} \tag{7}$$

The closeness of similarity *S* between two vectors is computed by equation (8).

$$S = 1 - AD \tag{8}$$

The perfect similarity is shown with $S = 1$ while $S = 0$ indicates the maximum degree of dissimilarity. Also, the direct relationship is shown with $S > 0$ means that any increase in V_1 results to an increase in V_2 and $S < 0$ means that an increase in V_1 results to a decrease in V_2. In the case of the inverse relationship between V_1 and V_2, *dj* is assumed by equation (9).

$$dj = \left|X_1\left(V_j\right) - \left(1 - X_2\left(V_j\right)\right)\right| \tag{9}$$

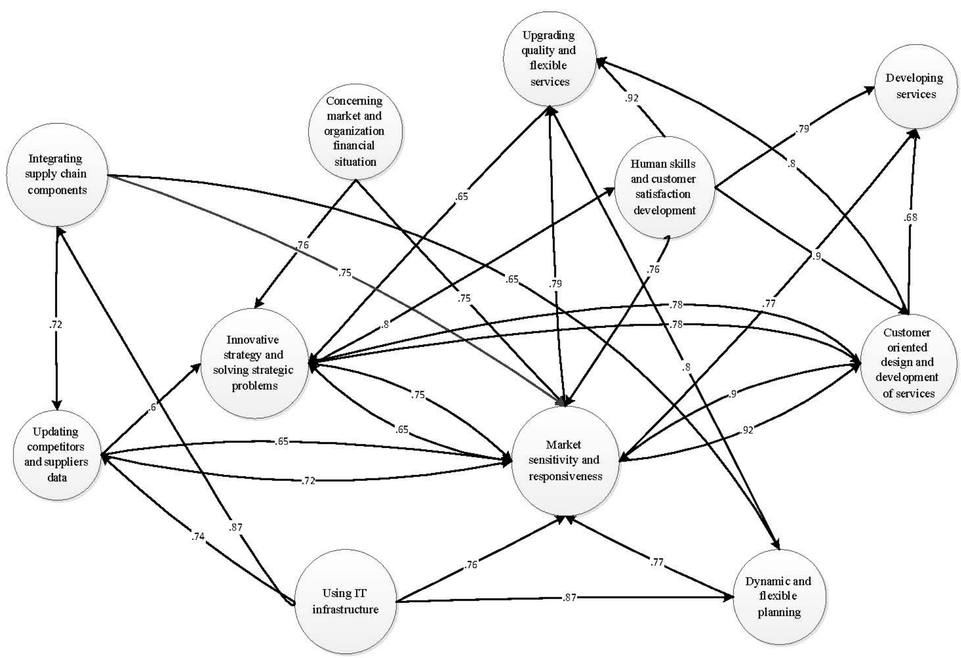
As mentioned before to evaluate average distance between two vectors and the similarity between them equations (7) and (8) are applied. The results of assumptions are illustrated in SRMS matrix which is illustrated in Table 7 presented in Appendix.

Step 4 There are some misleading data in SRMS matrix, because some the relationships between the CSFs are not existed in the real world. The experts' opinions are necessary once more to illustrate the real causal relationships between the factors. EOMC matrix is shown in Table 8 of Appendix. The columns and the rows of this matrix are the CSFs. The amount of each e_{ij} is 1 when there is the real relationship between two CSFs while this amount is zero if there are not any real relationships between them based on the experts' opinion. The types of enterprises their experts' opinions are applied in this matrix, mentioned before in Table 2. These experts as mentioned earlier are the managers, executers and consultants of the supply chain in the Iranian service providers.

The final matrix called FMS. Each row of this matrix is constructed from the multiplication of each row of EOMC matrix as a vector in the similar row of SRMS matrix .For example if we consider the second row of EOMC as a single vector and multiply it to the amount of the second row of SRMS matrix, the amount of second row of FMS matrix is achieved. Table 9 of Appendix illustrated the FMS matrix.

At the end, a graphical representation of the FMS matrix is drawn to show the causal relationships between the CSFs of SSCM in Iranian service provider enterprises. Figure3 represents this final graphical model.

Figure 3 The fuzzy cognitive map model of agile SSCM in the Iranian service provider enterprises



4 Managerial implications for service supply chain practitioners

The result of FCM shows that there are relations between the ASSCM factors and the numbers on the arcs is directed, signed and weighted which represent the causal relationships that exist between the factors. So, the bigger the number is, the more important is the effect of the first factor on the second one. As it can be seen in this model, the 'human skills and customer satisfaction development' affect on 'upgrading quality and flexible services' also on 'customer oriented design and development' with a very high degree (0.9 and more). It shows the very high importance of human skills, their knowledge and experience in identifying the main requirement of customers and fulfilling their needs to make them satisfactory, improving service quality and flexibility in an ASCM. This factor also can affect on developing the services and improve them with relatively high degree (0.7 to 0.8), while 'human skills and customer satisfaction development', itself can be affected by 'innovative strategy and solving strategic problems' which can improve the knowledge, orientation and strategic policies of staff in interaction with customers. On the other hand, between the 'market sensitivity and responsiveness' and the 'customer-oriented design and development of services' is a bilateral relationship with a very high degree (0.9 and more). This bilateral relationship between these two factors means that in designing a service and finding the requirements of the customer, market researching is very important while for responding quickly to the turbulent market, attention to the requirement of customers and listening to the customers' needs to compete with rivals is very significant. 'Using IT infrastructure' can affect on 'integrating the SSC components' also on 'flexible and dynamic planning' with the high degree of 0.87. This factor also affects on 'updating the competitors' and suppliers' data' and 'market sensitivity and responsiveness' with the relatively high degree of importance (0.7 to 0.8). This matter shows the importance of the IT role in sorting necessary data and creating useful information and transfers it through all the parts of the SSC, not only by integrating the SSC components, but also to increase the speed of responsiveness as one the important aspect of ASSCM.

Another bilateral relation in the model is between 'innovative strategy and solving the strategic problems' and 'customer-oriented design and development of services' with the relatively high degree of importance. It means the importance of innovative strategies and ideas to enhance customers' satisfaction, also attention and research in the customers' needs in making new ideas and service strategies. Some factors such as 'concerning market and organisation financial situation', 'upgrading competitors and suppliers data', 'innovative strategy and solving problems', 'developing services' and 'dynamic and flexible planning', with the relatively high degree (0.7 to 0.8) affect on 'the market sensitivity and responsiveness' as one of the main criteria of ASCM. This factor itself affect on 'upgrading quality and flexible services' with a relatively high degree of 0.79, which illustrates the importance of market research in R&D to improve the quality and flexibility in providing and delivering services. 'Innovative strategy and solving strategic problems' affected from the three factors of 'updating competitors' and suppliers' data and 'market sensitivity and responsiveness', also 'upgrading the quality and flexible services' with the average degrees of importance (0.6 to 0.7), which illustrates the importance of suppliers, market turbulence as the external factors and the effort for improving quality and flexibility as the internal factors in making ASSCM strategies. Another average relation in the model is the relationship between the 'customer oriented design and development of services' and 'developing services' which illustrates the significance of attention to customers' needs in designing and developing services as one of the principal stages of the service development processes.

As mentioned earlier the SSC managers should concentrate on these relations and prioritise them based on the degrees of impact of each relation to enhance the agility in the service SCM.

5 Conclusions

A service SCM is necessary to integrate and coordinate the different service operations performed in various organisations in order to deliver the services at the highest level of customer satisfaction. On the other hand, rapid growth of technology, risk-taking and increasing rate of unpredictable and constant changes in markets have led the organisations to face intensifying pressure for reduction of production and service cycle along with reduction of development costs, protection of desirable and rapid innovation and considering philosophy of earlier, better and cheaper production of goods and services. To overcome these unanticipated changes, considering and using the agility concept in all the parts of service supply chain is a necessity. Although the concept of the agile supply chain in the manufacturing industries, also the concept of the SCM were investigated by many types of research, the factors of agile SCM and modelling the relationships between its indicators have not been considered in the literature review. In this paper, the important factors of agility were extracted considering four aspects of agility in all sections of the supply chain in Iranian service provider organisations. Then, the significance of these factors was tested in the Iranian service providing enterprises and the CSFs in agility of supply chain were extracted with exploratory factor analysis method. Finally the causal relationships between the main factors were modelled with FCM technique. This FCM model introduced in this paper is a simple model can be perceived by researchers easily and any changes in the every parameter and its effect on the other factors can be analysed. Based on this FCM model, the service supply chain managers can concentrate on the most important factors such as 'human skills and customer satisfaction development', 'upgrading quality and flexible services', 'market sensitivity and responsiveness', 'customer oriented design and development of services'. On the other hand, the FCM method applied in this paper to achieve a causal model of agile SSCM is one of the common techniques. There are some methods of group decision-making techniques can show the cause and effect relationships between the variables. These methods are interpretive structural modelling (ISM) and decision-making trial and evaluation laboratory (DEMATEL). Also Structural Equation modelling as one of the most famous statistical based modelling techniques is one of the useful methods can present the causal relationships between the CSFs of a concept which is in our case was the ASSCM.

Furthermore, evaluating the agility in the service SCM and prioritising the agile SSCM factors, also using lean concepts besides the agility in SSCM are the other subjects can be investigated in the future studies.

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Appendix

Table 5 The IMS

F \ E	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
1	38	68	65	65	88	68	88	83	85	85	83	90	53	85	93	78	98	85	75	65	80	83	73	78	83
2	32	64	68	84	80	88	88	84	96	96	88	88	48	76	96	76	96	96	84	68	72	76	72	72	88
3	35	75	80	85	80	85	90	80	75	70	90	35	55	80	90	75	100	90	85	55	80	55	90	85	90
4	25	65	75	75	80	80	100	80	95	95	85	70	55	55	80	55	100	95	60	65	85	55	80	75	80
5	28	64	76	76	72	84	96	80	96	100	88	56	44	80	88	68	92	92	72	72	68	60	52	76	88
6	27	60	80	73	67	87	87	80	93	93	73	73	53	87	93	73	100	93	53	87	87	53	73	80	60
7	40	70	60	80	90	90	70	70	80	90	70	40	70	80	100	90	100	80	100	60	80	80	60	70	90
8	30	75	65	80	90	70	85	75	95	95	80	65	60	80	90	80	95	80	65	70	80	75	90	80	70
9	20	80	80	80	70	70	80	80	90	90	90	70	60	80	70	80	90	90	70	70	40	70	80	100	80
10	33	73	73	87	80	80	93	80	87	87	80	93	40	73	93	80	100	80	87	87	80	80	73	60	60
11	20	80	60	80	80	80	80	100	80	80	60	60	40	100	100	100	100	100	80	80	80	40	60	60	100

F \ E	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1	75	80	35	85	78	88	58	68	90	98	73	70	95	50	73	83	75	80	78	80	78	73	73	53	63
2	80	84	40	80	48	80	72	68	80	80	56	68	96	88	68	68	84	76	84	84	52	68	88	100	89
3	80	95	65	85	60	95	65	65	95	70	65	55	100	50	80	90	75	85	80	80	60	75	80	95	30
4	75	90	55	85	35	100	70	75	100	85	85	50	100	80	80	80	70	70	75	80	60	70	85	100	65
5	84	72	60	80	72	80	72	72	80	96	72	76	100	88	84	80	80	84	80	76	84	64	88	92	88
6	73	73	27	87	60	93	73	80	93	100	67	73	93	53	87	73	73	93	80	80	73	73	80	80	60
7	80	100	30	80	60	90	80	90	90	90	100	50	90	90	70	70	70	80	70	80	70	80	70	70	50
8	90	90	50	90	65	85	65	80	85	85	85	85	90	80	80	75	65	90	75	85	70	80	70	80	75
9	80	90	60	80	100	70	60	50	70	80	70	70	80	70	80	70	60	80	80	90	60	60	70	60	50
10	73	80	73	87	73	93	80	93	93	100	53	80	100	80	93	87	67	93	93	73	40	80	87	80	60
11	100	80	100	80	80	80	40	60	80	100	80	80	100	100	40	80	60	100	60	60	40	80	60	60	60

Table 5 The IMS (continued)

F \ E	*51*	*52*	*53*	*54*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*	*64*	*65*	*66*	*67*	*68*	*69*	*70*	*71*	*72*	*73*	*74*	*75*
1	35	73	65	80	73	90	83	80	75	73	63	65	68	73	68	78	78	80	73	73	63	88	65	65	88
2	40	88	76	80	76	88	88	64	68	64	84	92	64	88	76	92	84	84	72	100	60	84	72	52	92
3	50	70	65	95	80	95	85	60	85	55	70	85	65	80	75	85	75	85	75	85	60	95	80	80	85
4	55	65	65	90	75	100	65	65	70	75	75	95	75	80	85	90	80	95	80	75	95	50	55	75	80
5	32	80	56	76	60	80	92	60	72	68	68	80	72	80	76	84	88	76	72	88	76	88	88	52	92
6	27	60	87	60	80	80	87	60	73	67	47	60	80	73	73	80	87	87	80	67	80	87	47	53	73
7	60	60	70	70	50	100	70	60	70	70	60	70	80	70	80	80	80	80	70	60	50	80	80	20	90
8	75	80	85	70	65	90	85	70	80	75	75	75	75	75	65	95	75	95	55	80	75	80	80	60	75
9	40	70	100	40	60	60	80	80	90	100	70	60	80	70	90	80	80	90	80	60	70	80	90	80	80
10	53	87	87	60	67	87	87	73	80	87	73	80	67	80	67	73	73	67	67	67	67	80	80	53	73
11	80	60	100	100	60	100	100	80	80	80	60	80	60	80	40	80	60	40	80	80	100	80	80	60	80

F \ E	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*96*	*97*	*98*	*99*	*100*
1	30	45	85	60	98	58	75	65	83	43	83	83	68	83	78	80	78	85	88	90	80	80	53	65	65
2	60	76	64	76	100	60	72	68	84	28	88	76	84	56	72	80	48	80	80	80	72	72	48	60	60
3	80	80	90	65	100	70	35	75	95	50	75	75	95	65	80	80	60	85	95	95	80	80	55	75	75
4	25	55	70	85	95	65	75	80	85	60	75	60	85	45	80	80	35	85	100	100	85	85	55	95	35
5	44	52	72	52	96	72	60	56	96	44	72	68	88	68	80	80	72	80	80	80	68	68	44	56	56
6	67	67	53	27	100	67	87	67	80	40	93	60	80	80	67	80	60	87	93	93	87	87	53	73	73
7	40	40	70	60	80	80	60	80	90	40	70	80	90	90	80	80	60	80	90	90	80	80	70	80	85
8	45	85	65	75	90	75	80	75	85	45	100	90	90	70	80	80	65	90	85	85	80	80	60	80	90
9	60	80	70	70	90	80	90	70	90	50	50	80	60	80	90	90	100	80	70	70	40	40	60	40	40
10	27	27	73	60	87	60	47	73	87	47	87	80	93	53	67	80	73	87	93	93	80	80	40	80	85
11	40	100	80	80	100	80	60	80	100	40	80	60	100	100	100	80	80	80	80	80	80	80	40	60	60

Table 6 The FZMS

F \ E	*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*
1	0.2	0.8	0.7	0.7	1.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.9	0.7	1.0	1.0	0.9	1.0	1.0
2	0.1	0.7	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	0.9	1.0	0.9	1.0	1.0	1.0	0.8	0.8	0.9	0.8	0.8	1.0
3	0.1	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	1.0	0.1	0.5	1.0	1.0	0.9	1.0	1.0	1.0	0.5	1.0	0.5	1.0	1.0	1.0
4	0.0	0.7	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.5	0.5	1.0	0.5	1.0	1.0	0.6	0.7	1.0	0.5	1.0	0.9	1.0
5	0.0	0.7	0.9	0.9	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.3	1.0	1.0	0.8	1.0	1.0	0.8	0.8	0.8	0.6	0.5	0.9	1.0
6	0.0	0.6	1.0	0.9	0.8	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.5	1.0	1.0	0.9	1.0	1.0	0.5	1.0	1.0	0.5	0.9	1.0	0.6
7	0.3	0.8	0.7	1.0	1.0	1.0	0.8	0.8	1.0	1.0	0.8	0.3	0.8	1.0	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	0.7	0.8	1.0
8	0.0	0.9	0.7	1.0	1.0	0.8	1.0	0.9	1.0	1.0	1.0	0.7	0.6	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	0.9	1.0	1.0	0.8
9	0.0	1.0	1.0	1.0	0.8	0.8	1.0	1.0	1.0	1.0	1.0	0.8	0.7	1.0	0.8	1.0	1.0	1.0	0.8	0.8	0.3	0.8	1.0	1.0	1.0
10	0.1	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.6	0.6
11	0.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.7	0.7	1.0

F \ E	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*	*49*	*50*
1	0.9	1.0	0.1	1.0	1.0	1.0	0.6	0.8	1.0	1.0	0.9	0.8	1.0	0.4	0.9	1.0	0.9	1.0	1.0	1.0	1.0	0.9	0.9	0.5	0.7
2	1.0	1.0	0.2	1.0	0.4	1.0	0.8	0.8	1.0	1.0	0.5	0.8	1.0	1.0	0.8	0.8	1.0	0.9	1.0	1.0	0.5	0.8	1.0	1.0	1.0
3	1.0	1.0	0.7	1.0	0.6	1.0	0.7	0.7	1.0	0.8	0.7	0.5	1.0	0.4	1.0	1.0	0.9	1.0	1.0	1.0	0.6	0.9	1.0	1.0	0.0
4	0.9	1.0	0.5	1.0	0.2	1.0	0.8	0.9	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	0.8	0.8	0.9	1.0	0.6	0.8	1.0	1.0	0.7
5	1.0	0.8	0.6	1.0	0.8	1.0	0.8	0.8	1.0	1.0	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.7	1.0	1.0	1.0
6	0.9	0.9	0.0	1.0	0.6	1.0	0.9	1.0	1.0	1.0	0.8	0.9	1.0	0.5	1.0	0.9	0.9	1.0	1.0	1.0	0.9	0.9	1.0	1.0	0.6
7	1.0	1.0	0.2	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	0.8	0.8	0.8	1.0	0.8	1.0	0.8	1.0	0.8	0.8	0.5
8	1.0	1.0	0.4	1.0	0.7	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.7	1.0	0.9	1.0	0.8	1.0	0.8	1.0	0.9
9	1.0	1.0	0.7	1.0	1.0	0.8	0.7	0.5	0.8	1.0	0.8	0.8	1.0	0.8	1.0	0.8	0.7	1.0	1.0	1.0	0.7	0.7	0.8	0.7	0.5
10	0.9	1.0	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0	0.9	0.3	1.0	1.0	1.0	0.6
11	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.7	1.0	1.0	1.0	1.0	1.0	1.0	0.3	1.0	0.7	1.0	0.7	0.7	0.3	1.0	0.7	0.7	0.7

Table 6 The FZMS (continued)

F \ E	*51*	*52*	*53*	*54*	*55*	*56*	*57*	*58*	*59*	*60*	*61*	*62*	*63*	*64*	*65*	*66*	*67*	*68*	*69*	*70*	*71*	*72*	*73*	*74*	*75*
1	0.1	0.9	0.7	1.0	0.9	1.0	1.0	1.0	0.9	0.9	0.7	0.7	0.8	0.9	0.8	1.0	1.0	1.0	0.9	0.9	0.7	1.0	0.7	0.7	1.0
2	0.2	1.0	0.9	1.0	0.9	1.0	1.0	0.7	0.8	0.7	1.0	1.0	0.7	1.0	0.9	1.0	1.0	1.0	0.8	1.0	0.6	1.0	0.8	0.5	1.0
3	0.4	0.8	0.7	1.0	1.0	1.0	1.0	0.6	1.0	0.5	0.8	1.0	0.7	1.0	0.9	1.0	0.9	1.0	0.9	1.0	0.6	1.0	1.0	1.0	1.0
4	0.5	0.7	0.7	1.0	0.9	1.0	0.7	0.7	0.8	0.9	0.9	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0	0.5	0.5	0.9	1.0
5	0.1	1.0	0.5	0.9	0.6	1.0	1.0	0.6	0.8	0.8	0.8	1.0	0.8	1.0	0.9	1.0	1.0	0.9	0.8	1.0	0.9	1.0	1.0	0.5	1.0
6	0.0	0.6	1.0	0.6	1.0	1.0	1.0	0.6	0.9	0.8	0.4	0.6	1.0	0.9	0.9	1.0	1.0	1.0	1.0	0.8	1.0	1.0	0.4	0.5	0.9
7	0.7	0.7	0.8	0.8	0.5	1.0	0.8	0.7	0.8	0.8	0.7	0.8	1.0	0.8	1.0	1.0	1.0	1.0	0.8	0.7	0.5	1.0	1.0	0.0	1.0
8	0.9	1.0	1.0	0.8	0.7	1.0	1.0	0.8	1.0	0.9	0.9	0.9	0.9	0.9	0.7	1.0	0.9	1.0	0.5	1.0	0.9	1.0	1.0	0.6	0.9
9	0.3	0.8	1.0	0.3	0.7	0.7	1.0	1.0	1.0	1.0	0.8	0.7	1.0	0.8	1.0	1.0	1.0	1.0	1.0	0.7	0.8	1.0	1.0	1.0	1.0
10	0.5	1.0	1.0	0.6	0.8	1.0	1.0	0.9	1.0	1.0	0.9	1.0	0.8	1.0	0.8	0.9	0.9	0.8	0.8	0.8	0.8	1.0	1.0	0.5	0.9
11	1.0	0.7	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	0.7	1.0	0.7	1.0	0.3	1.0	0.7	0.3	1.0	1.0	1.0	1.0	1.0	0.7	1.0

F \ E	*76*	*77*	*78*	*79*	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*96*	*97*	*98*	*99*	*100*
1	0.0	0.3	1.0	0.6	1.0	0.6	0.9	0.7	1.0	0.3	1.0	1.0	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.7	0.7
2	0.6	0.9	0.7	0.9	1.0	0.6	0.8	0.8	1.0	0.0	1.0	0.9	1.0	0.5	0.8	1.0	0.4	1.0	1.0	1.0	0.8	0.8	0.4	0.6	0.6
3	1.0	1.0	1.0	0.7	1.0	0.8	0.1	0.9	1.0	0.4	0.9	0.9	1.0	0.7	1.0	1.0	0.6	1.0	1.0	1.0	1.0	1.0	0.5	0.9	0.9
4	0.0	0.5	0.8	1.0	1.0	0.7	0.9	1.0	1.0	0.6	0.9	0.6	1.0	0.4	1.0	1.0	0.2	1.0	1.0	1.0	1.0	1.0	0.5	1.0	1.0
5	0.3	0.5	0.8	0.5	1.0	0.8	0.6	0.5	1.0	0.3	0.8	0.8	1.0	0.8	1.0	1.0	0.8	1.0	1.0	1.0	0.8	0.8	0.3	0.5	0.5
6	0.8	0.8	0.5	0.0	1.0	0.8	1.0	0.8	1.0	0.3	1.0	0.6	1.0	1.0	0.8	1.0	0.6	1.0	1.0	1.0	1.0	1.0	0.5	0.9	0.9
7	0.3	0.3	0.8	0.7	1.0	1.0	0.7	1.0	1.0	0.3	0.8	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	0.8	1.0	1.0
8	0.3	1.0	0.7	0.9	1.0	0.9	1.0	0.9	1.0	0.3	1.0	1.0	1.0	0.8	1.0	1.0	0.7	1.0	1.0	1.0	1.0	1.0	0.6	1.0	1.0
9	0.7	1.0	0.8	0.8	1.0	1.0	1.0	0.8	1.0	0.5	0.5	1.0	0.7	1.0	1.0	1.0	1.0	1.0	0.8	0.8	0.3	0.3	0.7	0.3	0.3
10	0.0	0.0	0.9	0.6	1.0	0.6	0.4	0.9	1.0	0.4	1.0	1.0	1.0	0.5	0.8	1.0	0.9	1.0	1.0	1.0	1.0	1.0	0.3	1.0	1.0
11	0.3	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	0.3	1.0	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	0.7	0.7

Table 7 The SRMS (see online version for colours)

Factor	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1		0.87	0.75	0.86	0.86	0.84	0.86	0.65	0.84	0.87	0.72
2	0.87		0.86	0.87	0.89	0.65	0.85	0.88	0.83	0.87	0.82
3	0.84	0.79		0.92	0.86	0.65	0.77	0.85	0.84	0.83	0.82
4	0.86	0.80	0.90		0.86	0.78	0.68	0.86	0.82	0.84	0.81
5	0.86	0.92	0.76	0.90		0.86	0.79	0.87	0.84	0.86	0.83
6	0.84	0.85	0.75	0.78	0.80		0.83	0.85	0.83	0.83	0.78
7	0.86	0.85	0.84	0.84	0.86	0.83		0.88	0.84	0.84	0.83
8	0.85	0.80	0.77	0.86	0.87	0.85	0.88		0.87	0.87	0.86
9	0.84	0.83	0.75	0.82	0.84	0.76	0.84	0.87		0.82	0.82
10	0.87	0.87	0.76	0.84	0.86	0.83	0.84	0.87	0.82		0.74
11	0.82	0.82	0.72	0.65	0.83	0.60	0.83	0.86	0.82	0.84	

Table 8 Experts' opinions matrix of causality (EOMC)

Factor	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1		0	1	0	0	0	0	1	0	0	1
2	0		0	0	0	1	0	0	0	0	0
3	0	1		1	0	1	1	0	0	0	0
4	0	1	1		0	1	1	0	0	0	0
5	0	1	1	1		0	1	0	0	0	0
6	0	0	1	1	1		0	0	0	0	0
7	0	0	0	0	0	0		0	0	0	0
8	0	1	1	0	0	0	0		0	0	0
9	0	0	1	0	0	1	0	0		0	0
10	1	0	1	0	0	0	0	1	0		1
11	0	0	1	1	0	1	0	0	0	0	

Table 9 Final matrix of success (FMS) (see online version for colours)

Factor	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
1			0.75					0.65			0.72
2						0.65					
3		0.79		0.92		0.65	0.77				
4		0.80	0.90			0.78	0.68				
5		0.92	0.76	0.90			0.79				
6			0.75	0.78	0.80						
7											
8		0.80	0.77								
9			0.75			0.76					
10	0.87		0.76					0.85			0.74
11			0.72	0.65		0.60					