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PROPOSING AN AGILE STRATEGY FOR A STEEL INDUSTRY SUPPLY CHAIN THROUGH THE INTEGRATION OF BALANCE SCORECARD AND INTERPRETIVE STRUCTURAL MODELING

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Abstract. The internal and external environment of all organizations challenges them adapt to the best practices and reconsider their relationship throughout the supply chain. In this paper, the authors have tried to propose an agile strategy for the supply chain of a steel company, which ranks 3rd in Iran in Gross Sale with 16,000 employees, in order to respond quickly to ever-changing needs. To do this, through the literature review the framework of balanced scorecard was utilized to structure agility factors in the supply chain of the steel industry. Then the experts were interviewed to reconcile on the factors identified. Utilizing 24 questionnaires by the use of Interpretive Structural Modeling framework, the relationship and sequence of factors were obtained from experts. The final model developed in the paper presents the agility factors for the steel industry supply chain. Also, these factors are grouped within the four perspectives of the BSC to better enhance the results and pursue action. The ISM method identifies the priority of each factor which provides a better understanding of the underlying relationship of the factors for the managers to implement the strategies more reliably. The proposed model for strategy formulation can be utilized in strategy formulation problems over various types of supply chain.

Keyword: agility, steel industry, supply chain management, strategy formulation, balanced scorecard, Interpretive Structural Modeling.

JEL Classification: C63.

Introduction

Quick changes in the market are now more vivid than ever. Technology is developing and new products enter the market every day. Costumers' tastes undergo changes and the behavior of competitors is not predictable. In this environment, formulation of a strategy for the supply chain is a critical issue. Qrunfleh and Tarafdar (2013) defined supply chain strategy as a set of techniques used to integrate suppliers, wholesalers, production process and warehouses with the aim of producing goods with appropriate volume and price and distribution at the right time and right place in order to reduce chain costs and increase customer satisfaction. Not only delivering the right commodity in such a setting is the most important thing in order to achieve success in the market, but also it plays a key role in the survival of the business organizations (Agarwal *et al.* 2007). Due to aforementioned changes, the supply chain management practices are facing numerous challenges and traditional viewpoints in supply chain management have lost their effectiveness.

One of the most issues that can be addressed is agility and what comes next is the development of strategies fit for the supply chain management practices conforming to ever changing market and values (Teece *et al.* 1997). An agile SCM not only reacts to common alterations but also can react to the dramatic changes in the market, which hits for the first time. Also, the current market demand for customized products has increasingly displayed shorter life cycles for products (Ameri, Patil 2012). Therefore, it is believed that this agility is the needed characteristic for the future rivalry pressures of the company to acquire competitive advantages (Yusuf *et al.* 1999; Giachetti *et al.* 2003).

The critical importance of an agile SCM poses the question of proper tools and practices. One must develop strategies in line with agility characteristics for the supply chain. It should be noted that the selection of an agile supply chain is not the only question. One must assure the practices of this strategy is trustworthy? In this case, the need for balance scorecard to develop strategies with a glance at the status and targets is vivid. This paper intends to develop agility strategies for the supply chain. In this regard, one of the most compatible tools for strategy formulation is BSC. BSC is one of the most complete tools to develop strategy and performance evaluation, which entails most of performance and operation based criteria (Ravi, Shankar 2005). On the other hand, one of the limitations of BSC is the interconnectivity of the factors identified. To cover this weakness ISM method is utilized to discover the interrelationship of these factors (Agarwal *et al.* 2007). ISM is a mutual process in which a set of different and related elements is structuralized together in a systematic model (Dev *et al.* 2014). The methodology of ISM helps to establish order in a complex relationship between parts of a system (Agarwal *et al.* 2007). ISM could also prioritize the importance of the objectives set in BSC perspectives (Huang *et al.* 2005). This paper is targeted to distinguish the agility factors and measuring scales in the framework of the balanced scorecard in order to propose strategies for the steel industry. This integration of techniques not only categorizes the factors in the applicable perspectives of BSC but also can prioritize the importance and interconnectivity of the factors. This could help managers to apply the objectives in order of importance. For a better understanding of the techniques (Agility factors, BSC, ISM), a practical example of a real steel company is presented.

1. Literature review

The concepts of BSC, performance measurement factors and ISM technique is reviewed based on the literature. The definitions are presented in accordance with the aim of this study. What comes next is the review of the key concepts in the study.

1.1. Balanced scorecard

With an understanding of the limitations posed by the financial indices, and furthermore, the broadness of other aspects of the organizations like customers and innovation processes, Robert Kaplan and David Norton published a paper in 1992 introducing balanced scorecard as a new managerial tool to develop strategies and performance measurement indices (Kaplan, Norton 1992, 2001, 2005). Nowadays, the balanced scorecard is among the 15 most used managerial tools, with the least levels of error and the most efficiency. Studies show that some 70% of American companies use this tool and according to Cunha Callado and Jack (2015), it can be the most completed strategy development and performance measurement tool. BSC includes most of the items and elements at work in an organization (Bentes *et al.* 2012). The future standing point of a company is the core of the BSC activities (Ravi, Shankar 2005).

Kaplan and Norton (1996a) add that BSC changes the mission statement and strategies of an organization to an inclusive set of measuring scales, which in turn paves the way to a framework better for strategic management and management systems. In other words, the BSC is a trick to translate strategy into action and in fact, it is a framework to change the insight of a company or organization into a set of functional scale on four perspectives: financial, customers, internal processes and learning and growth. Within BSC, these four aspects are defined and analyzed to develop strategies (Kaplan, Norton 2000).

1.2. Agile supply chain

According to the dictionaries, the term agile means “the having a quick resourceful and adaptable character”, “marked by ready ability to move with quick, easy grace”, and “ability to think and understand quickly”. Current state of art translates agility as an effective reaction to the changing and unpredictable environment to seize the opportunities and avoid threats with the aim of developing firms (Agarwal *et al.* 2007). Goldman *et al.* (1995) trace the roots of agility to the agile production, which Braunscheidel (2005) defines it as an increase in the functions of the originations to seize the moments. Furthermore, agility has been defined as an ability for an organization to react quickly to changes in demand, in both terms of variety and volume of the changes (Christopher 2000) or as permanent preparation to react and respond quickly to changes with an increase in the quality and simplification of the processes (Kisperska-Moron, Swierczek 2009). But in order to acquire competitive advantage in the changing environment of businesses, firms have to get in line with suppliers’ and customers’ needs and attract their cooperation to increase the level of agility, and to structure their own processes and functions (Christopher, Towill 2001).

Later on, the agile supply chain has gained tremendous interest within the industry and the academy (Chiang *et al.* 2012). An agile supply chain can be defined as the use of

market knowledge, to exploit the opportunities provided by the market, and responding rapidly to the changes (Mehralian *et al.* 2013).

Mason-Jones *et al.* (2000) define agile supply as using the market knowledge and the concept of the virtual company in order to utilize the beneficial opportunities in the ever-changing market. The literature review provides us with an extensive body of knowledge in the agile supply chain (Christopher 2000; Tolone 2000; Svensson 2001; Baker 2008; Agarwal *et al.* 2007). Svensson (2001) asserts that interchain trust can make a supply chain agile. Stratton and Warburton (2003) analyzed the inventory as a capacity to create an agile supply chain. Roh *et al.* (2014) worked on the sensitivity and responsiveness to the processes in the market. Swafford *et al.* (2006) analyzed the resiliency of agile supply chain. Very few of the studies have analyzed the critical success factors of the agile supply chain. Only, Power *et al.* (2001) investigated the main success factors for a supply chain in an inclusive manner.

1.3. Performance measurement in agile supply chain management

Van Hoek *et al.* (2001) tried to assess the agility capabilities in the supply chain. Besides identifying the necessary capabilities for an agile supply chain, they also provided audit procedures for evaluation and performance measurement. The summary of the factors throughout the literature is presented in Table 1.

The literature review reveals that there have been numerous studies taking into account the factors affecting supply chain performance. The contribution of this study is that it considers those factors with the strategies to achieve agility.

1.4. Interpretive structural modeling

Interpretive structural modeling was introduced and developed by Warfield (1974, 1976) as a methodology to understand and establish relationships among the complex parts of a system. It helps to figure out the internal relationship of variables and is an effective technique to analyze the effect of one variable on the others (Mishra, Sharma 2015). ISM can also prioritize the level of importance in the parts which can be utilized to better understand a designed model (Huang *et al.* 2005).

2. Process of developing the strategy

In order to develop the agile supply chain strategy (shown in Fig. 1), the first step is to identify the main success of an agile supply chain, second, these factors are structured within the dimensions of the balanced scorecard. Then the indices to evaluate these factors in terms of goals are developed to increase the level of applicability of strategies. Finally, using ISM techniques, the relationship and sequence of these factors are measured.

2.1. Critical success factors of agile supply chain

The result of the literature review is the factors, with the most popularity and conformity to the case being analyzed. These factors are summarized in Table 1.

Table 1. Agility factors identified by authors through literature review

No.	Factors	Reference
1	Improving staff skills	Power *et al.* (2001), Gunasekaran (1999), Yusuf *et al.* (1999), Plonka (1997), Sherehiy *et al.* (2007)
2	Implement information technology	Qrunfleh, Tarafdar (2013), Lee *et al.* (2000), Agarwal *et al.* (2007), Bal *et al.* (1999), Swafford *et al.* (2008), Gunasekaran (1999), White *et al.* (2005), Christopher (2000), Liu *et al.* (2013)
3	Integration process	Khaleghinasab *et al.* (2014), Agarwal *et al.* (2007), Harrison *et al.* (1999), Van Hoek (2001), Carr, Pearson (1999), Khawaja (2004)
4	Responsibility	Braunscheidel, C. Sures (2009), Harrison *et al.* (1999), Agarwal *et al.* (2007), Christopher (2000), Christopher, Towill (2001), Agarwal, Shankar (2002), Van Hoek (2001), Yusuf *et al.* (2004), Swafford *et al.* (2008), Ambe (2010)
5	Collaborative planning	Agarwal, Shankar (2002), Agarwal *et al.* (2007), Anderson, Lee (1999), Lee *et al.* (1997), Van Hoek (2001), Harrison *et al.* (1999), Christopher, Jüttner (2000), Mentzer *et al.* (2000)
6	Flexibility	Aronsson *et al.* (2011), Swafford *et al.* (2006), Gosling *et al.* (2013), Christopher, Towill (2001), Gunasekaran *et al.* (2008), Swafford *et al.* (2008), Braunscheidel (2005), Mason-Jones *et al.* (2000), Giachetti *et al.* (2003), Gosling *et al.* (2010)
7	New product introduction	Agarwal *et al.* (2007), Van Hoek (2001), Swafford *et al.* (2006), Power *et al.* (2001), Braunscheidel (2005), Swafford *et al.* (2008), Baramichai (2007)
8	Fast delivery	Power *et al.* (2001), Agarwal *et al.* (2007), Van Hoek (2001), Swafford *et al.* (2008), Gunasekaran *et al.* (2008), Swafford (2003), Mason-Jones *et al.* (2000)
9	Cost reduction	Mason-Jones *et al.* (2000), Van Hoek (2001), Swafford (2003), Agarwal *et al.* (2007), Cooper, Slagmulder (1998)
10	Customer satisfaction	Khaleghinasab *et al.* (2014), Yeung (2008), Mason-Jones, Towill (1999), Agarwal *et al.* (2007), Power *et al.* (2001), Yusuf *et al.* (1999), Braunscheidel, C. Suresh (2009)
11	Improve quality of product	Agarwal *et al.* (2007), Mason-Jones *et al.* (2000), Gunasekaran, McGaughey (2003), Tari *et al.* (2007), Beamon, Ware (1998)

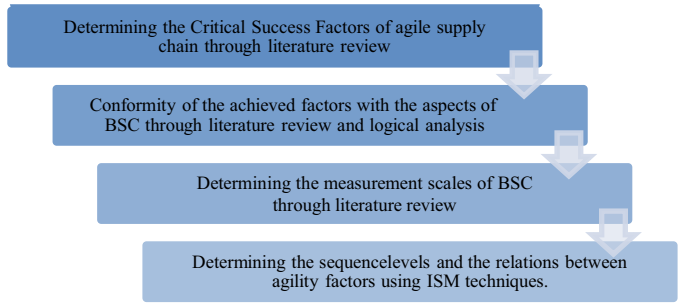

Fig. 1. Process of developing an agile supply chain strategy

2.2. Case introduction

Through literature review, the success factors of an agile supply chain are identified. Then through interviews with experts, these factors are reconciled with. Then they were structured within BSC as goals. Based on the interpretive structural model, a questionnaire was developed and distributed among the managers, experts, and industry officials. The sample employed in the research is the whole counting. In other words, all the accessible experts were contacted.

It should be noted that ZobAhan Company was selected as the a case. This company with the production rate of 550 thousand tons of steel and 2.2 million tons of iron per year is considered as the largest steel producer in Iran. Considering 16,000 workers, it can be categorized as a large company. This company ranks 3rd in Iran in Gross Sale.

2.2.1. BSC case analysis

Balanced scorecard (BSC) was developed by Kaplan and Norton (1996 a, b). BSC is now a popular tool, not only because it is a comprehensive and integrated performance measurement tool, but also it can be considered as a management system with the a new strategic approach (Fouladgar *et al.* 2011; Vukomanovic, Radujkovic 2013; Ng, Skitmore 2014). BSC offers a variety of performance indicators in four dimensions, financial, customer, internal business processes, and learning and growth (Bhagwat, Sharma 2007). What comes next is the list of indicators within each dimension developed by the researchers.

2.2.1.1. Financial perspective

Since this company is a public company, and gaining financial benefits are alongside with industrial advantages within the country, agility has to be defined in terms of very goals. To measure the benefits gained, 3 indicators are considered: return on the investment, the total price of the goods sold, and sales changes.

2.2.1.2. Customer perspective

There is a clear assertion on customer orientation in the company and the company tries to increase customer satisfaction through responding to the complaints, new product introduction, cost reduction, and quality products.

2.2.1.3. Internal processes pperspective

Internal processes are core to the agility of the operations in the company. Four objectives have been recognized, including delivery speed, flexibility, sensitivity and responsiveness to the market, and process integration.

As mentioned earlier, each of the four dimensions of the BSC is a part of a whole. The objectives and measures developed have been tested through literature analysis and experts' opinions. Each, in turn, creates the bed to obtain next. Internal processes and learning and growth perspective paves the way for customer perspective which ends in the financial benefits for the company.

2.2.1.4. Learning and growth pperspective

Constant learning is the main goal asserted by the company. Hence, 3 strategic goals are in line with the concept: development of skills in staff, use of IT, and collaborative planning.

The BSC perspectives, objectives, and measures are listed in Figure 2. Also, the adapted studies for the measures are summarized in Table 2.

When the objectives are set, the next step will be determining the causal relations of the objectives within BSC (Kaplan, Norton 1996a). Kaplan and Norton (1996a) declare that that first step is to set the learning and growth perceptive objectives. Internal processes are the next to be set and to be gained. When the objectives in learning and growth perspective and internal processes are accessed, the way will be paved for the objectives in the customer perspective. And at last, the financial goals will be fulfilled (Kaplan, Norton 1996b). However, besides determining the sequence of four perspectives in BSC, the sequence of the objectives is essential as well (Kaplan, Norton 1996b). This study intends to use ISM as a tool to analyze the sequence of objectives.

2.2.2. ISM case analysis

A step by step description of the methodology is presented in the next subsections.

2.2.2.1. Determining the variables of proposed model

ISM begins with the recognition of variables related to a concept (Agarwal *et al.* 2007). For example, the variables of this paper are the success factors of an agile supply chain. These factors are structured in the framework of BSC not only to propose strategies but also to apply them in practice.

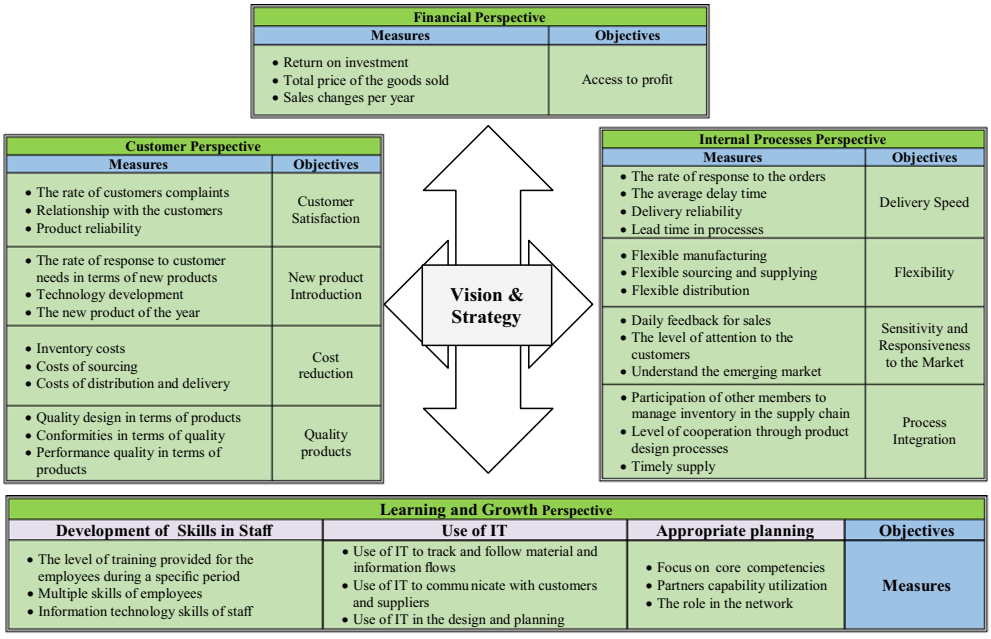

Fig. 2. Agility factors identified by authors through literature review

Table 2. Adapted objectives and measures through literature review

Perspectives and goals	Adapted studies	Measures
Financial		
Access to profit	Kaplan, Norton (1996b)	Return on investment
	Kaplan, Norton (1996b)	Total price of the goods sold
	Kaplan, Norton (1996b)	Sales changes
Customer		
Customer satisfaction	Yeung (2008)	The rate of customers complaints
	Yeung (2008)	Relationship with the customers
	Yeung (2008), Magretta (1998), Tan *et al.* (1998)	Product reliability
New product Introduction	Baramichai (2007), Braunscheidel (2005), Swafford (2003)	The rate of response to customer needs in terms of new products
		Technology development
		The new product development
Cost reduction	Hausman (2003), Patil (2006), Ramdas, Spekman (2000)	Inventory costs
	Hausman (2003)	Costs of sourcing
	Patil (2006), Swafford (2003), Frohlich, Westbrook (2001)	Costs of distribution and delivery
Quality products	Lau Antonio *et al.* (2007), Christopher, Towill (2001), Pall (1987)	Quality design in terms of products
	Rosenzweig *et al.* (2003), Lau Antonio *et al.* (2007)	Conformities in terms of quality
	Rosenzweig *et al.* (2003)	Performance quality in terms of products
Internal processes		
Delivery speed	Gillyard (2003), Yeung (2008), Power *et al.* (2001)	The rate of response to the orders
	Gillyard (2003), Ray (2001)	The average delay time
	Ghatari *et al.* (2013), Tseng *et al.* (2011), Agarwal *et al.* (2007),	Delivery reliability
	Gillyard (2003), Simchi-Levi *et al.* (2003), Grenoble (1994)	Lead time in processes
Flexibility	Swafford *et al.* (2006), Braunscheidel (2005), Swafford *et al.* (2008)	Flexible manufacturing
		Flexible sourcing and supplying
		Flexible distribution
Sensitivity and responsiveness to the market	Christopher (2000), Agarwal, Shankar (2002), Harrison *et al.* (1999)	Daily feedback for sales
		The level of attention to the customers
		Understand the emerging market

End of Table 2

Perspectives and goals	Adapted studies	Measures
Financial		
Process integration	Harrison *et al.* (1999), Braunscheidel (2005), Agarwal, Shankar (2002), Christopher (2000), Van Hoek (2001)	Participation of other members to manage inventory in the supply chain
		Level of cooperation through product design processes
		Timely supply
Learning and development		
Collaborative planning	Harrison *et al.* (1999), Christopher (2000)	Focus on core competencies
	Harrison *et al.* (1999), Christopher (2000)	Partners capability utilization
	Harrison *et al.* (1999), Christopher (2000)	The role in the network
Use of IT	Swafford *et al.* (2008), Swafford (2003), Helo (2006), Gunasekaran *et al.* (2008)	Use of IT to track and follow material and information flows
		Use of IT to communicate with customers and suppliers
		Use of IT in the design and planning
Development of skills in staff	Yusuf *et al.* (1999)	The level of training provided for the employees during a specific period
	Gunasekaran (1999), Yusuf *et al.* (1999)	Multiple skills of employees
	Gunasekaran (1999), Yusuf *et al.* (1999)	Information technology skills of staff

2.2.2.2. Structural self-interaction matrix (SSIM)

After the recognition of the variables, they are formed within structural self-interaction matrix. This is a matrix with the objectives in the first column. The dyadic relationship of the variables is shown in symbols (Ravi, Shankar 2005). These symbols include:
V: line agent (i) can lead to the column agent (j).
A: column agent (j) can lead to the line agent (i).
X: between line agent (i) and column agent (j) there is a mutual relationship. In other words, the agents can lead to each other.
O: there is no kind of relationship between these two agents (ij).

A questionnaire was designed and distributed among 30 managers and executive experts in the Esfahan steel company (ZobAhan Co.), of which 24 questionnaires were returned. Then the results of these questionnaires were presented to a group of 7 managers to check the conformity of the results. The final relation of the objectives was agreed on. The results are presented in Table 3.

Table 3. Matrix SSIM

No.	Variables	11	10	9	8	7	6	5	4	3	2
1	Development of skills in staff	V	V	V	V	V	V	X	V	O	X
2	Use of IT	V	V	V	V	O	V	X	V	V	
3	Process integration	V	O	V	V	O	X	A	V		
4	Sensitivity and responsiveness to the market	V	V	O	X	V	X	A			
5	Collaborative planning	V	V	V	V	V	V				
6	Flexibility	O	V	O	X	V					
7	New product introduction	O	V	A	O						
8	Delivery speed	O	V	V							
9	Cost reduction	A	V								
10	Customer satisfaction	A									
11	Quality product										

2.2.2.3. Reachability matrix

Using the following rules, SSIM matrix symbols were altered to zeroes and ones, and the reachability matrix (Table 4) is achieved (Faisal *et al.* 2006).

1. If the blocks (i, j) in SSIM matrix contain the symbol V, the block related to it in the reachability matrix takes number 1 and the identical block, (i, j) takes 0.
2. If the blocks (i, j) in the SSIM matrix contains the symbol A, the related block in the reachability matrix takes zero and its identical block, (j, i) takes 1.
3. If the blocks (i, j) in the SSIM matrix contain the symbol X, the related block in the reachability matrix takes 1 and the identical block, (j, i) takes number 1.
4. If the blocks (i, j) in the SSIM matrix contain the symbol O, the related block in the reachability matrix takes zero and the identical block (j, i) takes number 1.

Table 4. Reachability matrix

Row	Variables	1	2	3	4	5	6	7	8	9	10	11
1	Development of skills in staff	1	1	0	1	1	1	1	1	1	1	1
2	Use of IT	1	1	1	1	1	1	0	1	1	1	1
3	Process integration	0	0	1	1	0	1	0	1	1	0	1
4	Sensitivity and responsiveness to the market	0	0	0	1	0	1	1	1	0	1	1
5	Collaborative planning	1	1	1	1	1	1	1	1	1	1	1
6	Flexibility	0	0	1	1	0	1	1	1	0	1	0
7	New product introduction	0	0	0	0	0	0	1	0	0	1	0
8	Delivery speed	0	0	0	1	0	1	0	1	1	1	0
9	Cost reduction	0	0	0	0	0	0	1	0	1	1	0
10	Customer satisfaction	0	0	0	0	0	0	0	0	0	1	0
11	Quality products	0	0	0	0	0	0	0	0	1	1	1

2.2.2.4. Adapting reachability matrix

When the first version of the reachability matrix is achieved, its internal adaptation has to be done. For example, if variable number 1 leads to variable number 2, and it leads to variable number 3, therefore the first variable has to lead to variable number 3 as well and if in the reachability matrix this was not possible, the matrix has to be corrected and relationships which have been ignored must be replaced. Several methods have been proposed for the adaptation of the matrix, but in this study mathematical rules have been applied to the adaptation of the reachability matrix. The reachability matrix is powered to the power of K+1 and K>–1. The empowerment of the matrix has to be based on the rule of Bolen (Huang *et al.* 2005). Accordingly:

The result of the adaptation can be seen in Table 5. In this table, numbers with the symbol "*" show that they have been zero in the reachability matrix and after adaptation, their value will be 1.

Table 5. Reachability matrix after adaptation

Row	Variables	1	2	3	4	5	6	7	8	9	10	11
1	Development of skills in staff	1	1	1*	1	1	1	1	1	1	1	1
2	Use of IT	1	1	1	1	1	1	1*	1	1	1	1
3	Process integration	0	0	1	1	0	1	1*	1	1	1*	1
4	Sensitivity and responsiveness to the market	0	0	1*	1	0	1	1	1	1*	1	1
5	Collaborative planning	1	1	1	1	1	1	1	1	1	1	1
6	Flexibility	0	0	1	1	0	1	1	1	1*	1	1*
7	New product introduction	0	0	0	0	0	0	1	0	0	1	0
8	Delivery speed	0	0	1*	1	0	1	1*	1	1	1	1*
9	Cost reduction	0	0	0	0	0	0	1	0	1	1	0
10	Customer satisfaction	0	0	0	0	0	0	0	0	0	1	0
11	Quality product	0	0	0	0	0	0	1*	0	1	1	1

2.2.2.5. Determining the level and priority of the variables

In order to determine the level and priority of the variables, reachability set and antecedent set are determined for each variable (Mandal, Deshmukh 1994). The reachability set includes all the variables that can be reached through this variable and the antecedent set is all the variables through which these variables can be accessed (Huang *et al.* 2005). This can be done through reachability matrix. When the reachability set and antecedent set are determined for each variable, the common parts for each variable of reachability set and antecedent are recognized.

When the reachability set and antecedent set are determined and their common parts, it's time to determine the level of variables. In the first table, a variable has the highest level whose reachability set and antecedent set are the same (Agarwal *et al.* 2007). When these variables are determined, they are eliminated from the table and using the rest of the variables, the next table is formed. In the second table, like the first table, the second level variable is determined and this is done to determine all the levels of the variables

(Agarwal *et al.* 2007). In the present study, all of the results have been summarized in Table 6 and the levels of all the variables have been determined. Customer satisfaction, being the main goal of the agile supply chain is on the first level and development of skills in staff, use of IT and collaborative planning are on the lowest level.

Table 6. Determining the level of the variables

Row	Variables	SSIM	Prerequisite	Common	Level
1	Development of skills in staff	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 5	1, 2, 5	Sixth
2	Use of IT	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 5	1, 2, 5	Sixth
3	Process integration	3, 4, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 8	3, 4, 6, 8	Fifth
4	Sensitivity and responsiveness to the market	3, 4, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 8	3, 4, 6, 8	Fifth
5	Collaborative planning	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2, 5	1, 2, 5	Sixth
6	Flexibility	3, 4, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 8	3, 4, 6, 8	Fifth
7	New product introduction	7, 10	1, 2, 4, 5, 6, 7, 8, 9, 11	7	Second
8	Delivery speed	3, 4, 6, 7, 8, 9, 10, 11	1, 2, 3, 4, 5, 6, 8	3, 4, 6, 8	Fifth
9	Cost reduction	7, 9, 10	1, 2, 3, 4, 5, 6, 8, 9, 11	9	Third
10	Customer satisfaction	10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	10	First
11	Quality products	7, 9, 10, 11	1, 2, 3, 4, 5, 6, 8, 11	11	Fourth

2.2.2.6. Analysis of MICMAC

In MICMAC analysis, the variables are categorized into four groups according to driving power and dependence power (see Fig. 3). The first set consists of autonomous variables whose leading and dependency power is weak. These variables are rather disconnected from the system and their relationship with the system is very weak (Agarwal *et al.* 2007). In this study, no variable was put in this group, and this shows the strong relationship between the variables in the process of developing strategies. Dependent variables are the second group with little leading power, but high dependency. Quality product, customer, new product introduction, and cost reduction are all in this group. These variables are mostly the result of agility for which a lot of factors are at work to create them and they themselves very seldom lead to other variables.

Customer satisfaction is the most outstanding among the others. The third group is the linkage variables with high leading power and high dependency (Ravi, Shankar 2005). These variables are unstable (Non-stationary) because any kind of change in any of them can affect the system and in turn, the feedback of the system can affect these variables as well. These variables include process integration, sensitivity and responsiveness to the market, flexibility, and delivery speed.

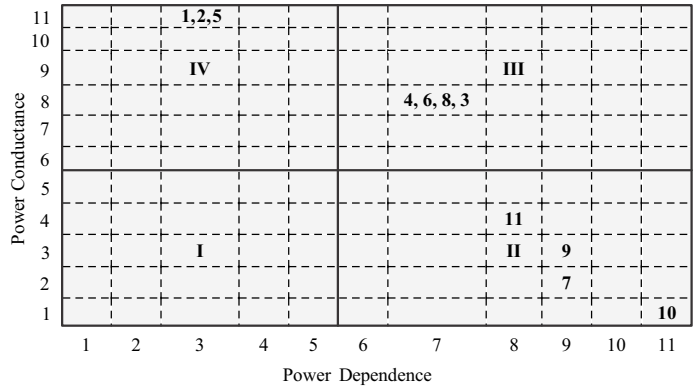

Fig. 3. Diagram of leading power and dependency

The fourth group is dependent variables with strong leading power but weak dependency. This group plays the role of the cornerstone of the model and in order to begin the system, they have to be asserted. Development of skills in staff, collaborative planning, and use of IT are in this group. Development of skills in staff is the most outstanding in this group and in order to achieve an agile supply chain, it has to be worked on.

3. Final model

When the levels and relationships of the variables are achieved (objectives in BSC) a map is drawn, as shown in Figure 4. The Figure shows that the variables are categorized into 6 groups. On the highest level lies customer satisfaction. On the lowest level, development of skills in staff, use of IT and collaborative planning whose role is the cornerstone of the model and agility has to start with these variables and take root to the other variables. These 3 variables have a mutual relationship and have led to the fourth perspective of BSC, that is learning and growth. The fifth level includes 4 variables: process integration, sensitivity and responsiveness to the market, flexibility and delivery speed, all of which have a mutual relationship with one another.

Quality products affect cost reduction (third level) and the cost reduction affects the new product introduction (second level). All of variables at level 2, 3, 4 and 5 of and 3 variables at sixth level have effects on these four variables. These four variables have also a one-way relationship with the quality products (fourth level). The result of ISM is the formation of the third perspective in BSC, the internal process. When these objectives are acquired, the bed to fulfill the customer satisfaction is paved (first level in the ISM and second perspective in the BSC).

Discussion and conclusions

In this study, we tried to develop a strategy for an agile supply chain in the steel industry so that it can react properly to the changes in the market and adjust to the tastes of the customers. Hence, we decided to utilize ISM and BSC techniques and also the concept

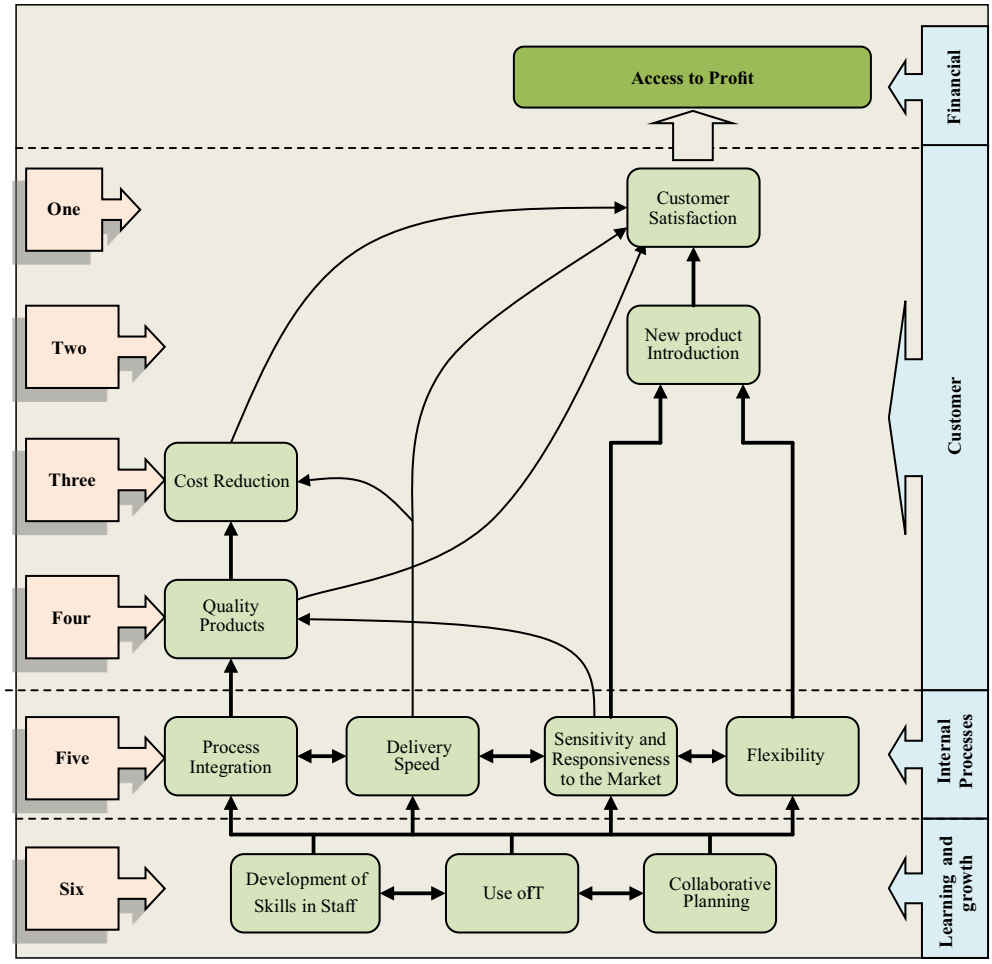

Fig. 4. Proposed agile supply chain criteria for the steel industry

of agility, and develop the agile supply chain strategy. For this purpose, after reviewing the literature on the concept of agility in supply chain and also investigating the company and interviewing the managers and experts within and outside supply chain, eleven factors were identified with a key role in the agility of the supply chain. These factors include: collaborative planning, use of information technology and staff's skill development in the learning and growth perspective; delivery speed, flexibility, sensitivity and responsiveness to the market, and process integration in the internal processes perspective; customer satisfaction, new product introduction, cost reduction and product quality in the customer perspective and ultimately the profit in the financial perspective. These factors are reconciled on by many researchers considering the concept of agility in the supply chain. We have also conducted interviews with experts to confirm the importance. After recognizing these factors, they were structured in BSC perspectives and their measurement scales were developed. Then, using ISM techniques, their con-

tinuance and relationship were measured. The findings of the study show that 3 factors, staff's skill development, use of IT and collaborative planning are at the lowest level of the ISM and they form the learning and growth perspective of BSC. This means, to begin to make the supply chain agile, one has, to begin with these factors, which lead to the agility of the factors in the higher level (processes integration, sensitivity and responsiveness to the market, flexibility and delivery speed). The results are obtained from MICMAC analysis. These factors have a high level of leading power and can lead to other factors. The second set of these factors include process integration, sensitivity and responsiveness to the market, flexibility and delivery speed, with high leading power and also a high level of dependency. These factors play the role of the medium from previous factors to the next factors. They are categorized in the internal processes perspective of BSC.

The result of this study contributes to the literature in the sense that BSC and ISM integration reveals the importance of each factor and also relates the relationship and priority of each. The factors related to learning and growth in the ISM and BSC are put at the lowest level. In the next level, the factors related to the internal processes are placed and in turn, factors related to the perspective of customers, and then financial factors. This means that in order to plan and perform a strategy, the learning and growth perspectives are to be achieved. This leads to the growth and development of internal processes. If these two aspects are gained, the third perspective (customer satisfaction) emerges and as a result of all these, the fourth perspective (financial) emerges. This lets managers know what to take into consideration when taking actions. In addition, using BSC makes it possible to perform the strategy properly.

As mentioned earlier, supply chain includes 3 subcategories, suppliers, manufacturing or service organization, and customers. In this study, an agile strategy for all the chain was developed at the same time. If one develops strategy separately for each of the 3 parts of the supply chain, it helps the outcomes and covers this limitation. So, future studies could handle this issue. Another limitation of this study is the case analyzed. Future studies can develop the population to an industry and study more companies at the same time. This can lead to the results with more generalizability. Another branch of research in this regard can be the management of knowledge, with a key role in designing agility strategy.

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