Time to get into the action

Unveiling the unknown of innovation capability in Indian MSMEs

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Abstract

Purpose – The aim of this study is to identify and rank the factors of innovation capability (IC) in Indian micro, small and medium enterprises (MSMEs). This study focuses on ascertaining the important factors that help in enhancing the IC with an emblematic focus on the MSME sector of India.

Design/methodology/approach – This paper proposes a multicriteria decision-making methodology, which is based on fuzzy analytic hierarchical process to prioritize the factors that enhance the IC of MSMEs. Finally, sensitivity analysis is conducted to examine the ranking stability.

Findings – Knowledge management is the most important enabler, followed by creativity and idea management and organizational culture.

Practical implications – Several organizations promote the strategic measures for enhancing the IC. To increase their capability to innovate, there is a need to identify, acknowledge and implement the drivers of IC into practice.

Originality/value – Prioritization done in the study facilitates the entrepreneurs to determine the most important factors that need crucial attention in dealing with sensitive issues of IC. Entrepreneurs can take several steps to implement the most important factors for enhancing the IC into practices for meeting the needs of the consumers, generating profits and enhancing the competitiveness.

Keywords India, MCDM, Fuzzy AHP, MSMEs, Innovation capability (IC)

Paper type Research paper

1. Introduction

Innovation is an attractive, yet ambiguous goal for several organizations. It promises to enhance the profits, satisfy the needs of the customers, increase market exposure, gain the competitive advantage, provide sustainable development and give better performance (Chen *et al.*, 2018; Srivastava *et al.*, 2017; Swann, 2018; Gunday *et al.*, 2011; Kuratko *et al.*, 2005; Teece, 2007; Stock *et al.*, 2002). The reason innovation is so valuable is that it is rare. The present scenario of globalization, multifaceted business environment, smaller product life cycle and vertical integration has elevated the significance of innovation for all

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organizations and particularly for micro, small and medium enterprises (MSMEs). Disruptions are unpredictable in a dynamic business environment. For enhancing the sustainability and competitiveness of a business, the process of innovation capability (IC) must be intended in such a way that it will produce effective and efficient innovations, thereby making it capable of generating higher returns and increased market exposure (Stock *et al.*, 2002). The process of IC is multidimensional and aims at developing more and more innovations for reducing vulnerability. The potential to generate the innovation is called IC (Neely *et al.*, 2001). It can be enhanced by enhancing the capability to innovate (Fruhling and Siau, 2007; Saunila and Ukko, 2012).

In a turbulent business environment, an enterprise must possess the ability to reconstruct, renew and recreate the available resources to develop the IC. The IC of enterprises can be described in several perspectives. Thus, according to Bergendahl *et al.* (2008), IC includes the ability to adapt to the new environment, technical learning and organizational learning and work procedures. Lawson and Samson (2001) identify seven constructs ("vision and strategy, harnessing the competence base, organizational intelligence, creativity and idea management, organizational structure and systems, culture and climate, and the management of technology") of IC and claim that organizations that explicitly generate and invest in these seven constructs are able to achieve sustainable innovation outcomes. Whereas, Olsson *et al.* (2009) identified six elements of an innovative organization. These elements explain the benefits as well as challenges attached while approaching IC.

The key to enhance IC is the identification of all the possible factors that may help in generating the capability to innovate. Proactive application of the strategies to enhance the probability of developing the IC (even in uncertainty) and effective planning for enhancing IC provide deep insights for an effective decision-making process. Factors enhancing the IC should be primarily addressed for enabling innovation in an organization.

Factors of IC are somewhat interlinked. One driver of IC may have a direct positive influence over the other driver. To identify the factors of IC, they must be prioritized based on their overall influence over the other driver. The primary objective of the study is to prioritize the enablers of IC in the MSME sector of India.

The original contribution of this study is the application of the technique and its managerial implications. The fuzzy analytic hierarchical process (AHP) technique has been applied in this study to determine the rank of the factors of IC in the MSME sector. As the drivers of IC are interlinked, entrepreneurs must rank their selection, application, review and maintenance on those drivers that are extremely important. The rationale of the study is to provide a better understanding on enablers of innovation, especially for MSMEs, on one platform by providing the ranking of the enablers and to provide the future scope related to this area, which will help scholars, entrepreneurs, managers and policymakers. Author claims that this study will provide a path for future research in generating IC with the proper application of appropriate factors of IC. Finally, to ensure the robustness of the findings, sensitivity analysis was also performed.

This study is organized into six sections. Section 1 describes the introduction of the study. Section 2 explains the factors of IC and its related literature, followed by MSMEs in India. In Section 3, methodology used in the study is explained. Section 4 provides the results of this study, followed by Section 5, which deals with sensitivity analysis and managerial implication. This paper will end with conclusion and future scope in Section 6.

2. Literature review

2.1 Existing literature related to innovation capability

As mentioned earlier, IC is one area on which significant research has been carried out. Studies have examined the relationship that IC shares with various organizational variables

in different contexts. Organizations with well-defined constructs of IC perform better because knowledge of such constructs makes it easier to identify which areas need attention to develop IC; organizations without such knowledge would not know where to invest in the first place (Lawson and Samson, 2001; Olsson *et al.*, 2009). The authors in this study have identified seven enablers of IC from available literature. Majority of these drivers are those that have been mentioned most frequently by researchers.

Resources are defined as the available assets in an organization that include knowledge, organizational features, skills, potential, etc. These are controlled by the organizations, as it enables them to conceive and execute and implement the strategies that help in enhancing the efficiency and effectiveness of innovation in the market (Barney and Clark, 2007). Resources are divided in two groups: operant resources and operand resources (Constantin and Lusch, 1994). Hunt (2004) defined the operant resources as human skills, knowledge and information, be it about the technologies, customers, competitors, etc., as well as the relational and organizational knowledge, like routines and control mechanism, whereas the operand resources are physical (tangible) resources. It is reported that the operant resources are more vital for IC than the operand resources (Lin, 2007; Du Plessis, 2007; Camps and Marques, 2014). According to Kamath *et al.* (2016), knowledge management (KM) has also been identified as the most important enabler of IC.

Capabilities constitute knowledge that acts as a tool to enhance skills where the skills refer to the ability to do things with expertise. According to Wood *et al.* (1976), skills can be defined as operant's capabilities, whereas knowledge is a mental frame. Lin (2007) has identified a positive relationship between knowledge sharing and IC of an organization.

Fang *et al.* (2014) claimed that not only internal resources but also inter-firm innovation networks play a crucial role in attaining the competitive advantage. Moreover, collaboration that assists in enhancing the firm's IC is important. It was found that networking capabilities have four antecedents: openness of the culture, experience with network capabilities, IT maturity and the management system involved (Fang *et al.*, 2014), which have been empirically validated. Romijn and Albaladejo (2002) and Kallio *et al.* (2012) posit the importance of collaboration for enhancing IC.

Camps and Marques (2014), Yang (2012) and Saleh and Wang (1993) claimed that the propensity to take risk was one of the drivers that increased the IC of an organization. It is very important for every organization to develop openness to criticism and failure and the ability to tolerate ambiguity. Song and Di Benedetto (2006), Wagner and Hoegl (2006) and Hartley *et al.* (1997) cited supplier involvement as one of the important drivers of IC.

Involving customers and the suppliers in the process of production helps in enhancing the capability to innovate. To build customer loyalty, maximize profits and attract new customers, customer involvement in the process of innovation is important (Feng *et al.*, 2010). Morrison *et al.* (2000) also concluded that in developed economies, majority of technological innovations had been generated through involvement of customers in the innovation processes.

Several previous research works claimed that involvement of the supplier is important for the development of innovations. Song and Di Benedetto (2008) identified a positive relationship between supplier participation and radical innovation. Wagner and Hoegl (2006) also posit that supplier involvement in new product development is vital and even inevitable in some organizations. But, several issues must be taken care of. First, the criteria for selecting suppliers (Wagner and Hoegl, 2006; Wynstra *et al.*, 2003) is an important issue in the case of supplier involvement. The appropriate time for involving the supplier is another crucial issue that must be taken into account. McGinnis and Vallopra (1999, p. 14) suggested that organizations must engage suppliers only at the time of need and for

developmental aspects. Hartley *et al.* (1997) stressed on the participation of suppliers in the initial stage of the product development process, whereas Eisenhardt and Tabrizi (1995) pointed out that it depends on the situation.

Technology management is vital for every organization in the current business environment. Lawson and Samson (2001) claimed that innovative organizations were those that were able to link their innovation and business strategies with technological strategy. Adoption of new technology helps in developing the capability to innovate by maintaining a database of suppliers and customers along with their preferences. Yang (2012) and Castro *et al.* (2013) also asserted that investment in appropriate technologies helped in enhancing IC. Other research work conducted by Tarafdar and Gordon (2007) and Khosrow-Pour (2006) identified the positive relationship between technology management and IC.

Beliefs, norms, values and assumptions determine the climate of an organization. Martensen *et al.* (2007) and Neely *et al.* (2001) claimed that the organizational climate (OC) facilitated the culture of innovation in an organization and helped in increasing the number of innovations. Smith *et al.* (2008); Wan *et al.* (2005) and Lawson and Samson (2001) emphasized the importance of the OC in facilitating proper communication in organizations, supporting that OC enhanced collaboration with other organizations (Smith *et al.*, 2000), which in turn helped in developing the IC of an organization. Several other authors, such as Slater *et al.* (2014); Saunila and Ukko (2013); Sharifirad and Ataei (2012); Kallio *et al.* (2012); Rujirawanich *et al.* (2011); Skarzynski and Gibson (2008); Leskovar-Spacapan and Bastic (2007) and Lawson and Samson (2001), have also stressed the importance of the OC in developing IC.

Creativity, defined as a process of generating novel ideas (Amabile *et al.*, 1996), is an important construct of IC (Lawson and Samson, 2001; Ahlin *et al.*, 2014; Camps and Marques, 2014). Every organization must explicitly encourage creativity because only through enhancement of creativity, the organization will have better chances of achieving sustainable innovation. It was also concluded that knowledge sharing within the organization influences IC by supporting creativity (Perry-Smith and Shalley, 2003) and encouraging novel ideas and knowledge (Aragón-Correa *et al.*, 2007).

The summary of these enablers is given in Table I.

2.2 Micro, small and medium enterprises in India

In India, there are approximately 46 million MSMEs across the several industries employing more than 106 million people. Maximum numbers (94 per cent) of enterprises in this sector are unregistered. In India, after agriculture, this sector provides employment to the maximum number of people and plays a very crucial role in the industrialization of rural as well as urban areas. The MSME sector complements the larger organizations and significantly contributes to the economic and social prosperity of the country. The contribution of this sector was very significant in the past decades, as it stands at approximately 40 per cent of the total nation export to 45 per cent of the total manufacturing output with 8 per cent of the gross domestic product. This particular sector of the economy holds the significant potential to enhance the industrial growth of the nation. Further, this sector contributes in the development of the nation through contribution to operational flexibility, contribution toward defense production, technology-oriented industries, location-wise mobility, capacities to develop appropriate indigenous technology, import substitution, low-investment requirements, low-intensive imports, domestic production, significant export earnings and competitiveness in national and international markets, thereby creating new entrepreneurs by providing training and knowledge.

Sr. no.	Innovation capability enablers	References	Description
1	Knowledge management (KM)	Taherparvar *et al.* (2014), Yusur *et al.* (2014), Levi-Jakšić *et al.* (2013), Yeşil *et al.* (2013), Kumar and Che Rose (2012), López-Nicolás and Meroño-Cerdán (2011), Lin (2007), Miller *et al.* (2007), Rollins and Halinen (2005), Subramaniam and Youndt (2005), Gibbert *et al.* (2002), Romijn and Albaladejo (2002), Cohen and Levinthal (1989, 1994)	The improvement of knowledge generation or transfer through knowledge acquisition, assimilation and dissemination, technological knowledge, prior related knowledge and customer and employee knowledge management
2	Risk-taking (RT)	Jaworski and Kohli (1993), Hurley and Hult (1998), Calantone *et al.* (2002), Guan and Ma (2003), Akman and Yilmaz (2008), Hull and Covin (2010), Forsman (2011), Camps and Marques (2014)	Ability to try new methods and approaches without any control over the consequences
3	Actor's participation (AP)	Jeng and Pak (2014), Ahlin *et al.* (2014), Camps and Marques (2014), Saunila and Ukko (2014), Kallio *et al.* (2012), Sharifirad *et al.* (2012), Martinez-Roman *et al.* (2011), Feng *et al.* (2010), Olsson *et al.* (2009), Song and Di Benedetto (2006), Wagner and Hoegl (2006), Wan *et al.* (2005), Lawson and Samson (2001), Morrison *et al.* (2000), Hartley *et al.* (1997)	Actor's participation includes participation of customers, suppliers and employees in the process of innovation
4	Creativity and idea management (CIM)	Tang (1998, 1999), Kallio *et al.* (2012), Lawson and Samson (2001), Smith *et al.* (2008), Flynn *et al.* (2003), Sandstrom and Bjork (2010), Alessi *et al.* (2015)	It includes the idea generation, improvement, selection and implementation
5	Information and technology management (ITM)	Castro *et al.* (2013), Yang (2012), Tarafdar and Gordon (2007), Gordon and Tarafdar (2007), Khosrow-Pour (2006), Lawson and Samson (2001), Dyche (2001)	Technology-based CRM, use of information technology and ability to adapt to latest technology
6	Organizational climate (OC)	Donkor *et al.* (2018), Russell (1990), Damanpour (1991), Nonaka and Takeuchi (1995), Hurley and Hult (1998), Tang (1998, 1999), Neely *et al.* (2001), Lawson and Samson (2001), Guan and Ma (2003), Brockman and Morgan (2003), Wan *et al.* (2005), Li and Kozhikode (2009), Hull and Covin (2010), Wonglimpiyarat (2010), Martinez-Roman *et al.* (2011), Kallio *et al.* (2012), Saunila and Ukko (2013), Slater *et al.* (2014)	It includes level of decentralization (decision-making power), control and supervision (hierarchical power), presence of communication system and liaison resources in an organization, organizational structure and culture and reward system. Values, beliefs and norms also determine the organizational climate
7	Collaboration (CO)	Romijn and Albaladejo (2002), Kallio *et al.* (2012), Fang *et al.* (2014)	Collaboration with research institutes, universities, government, nongovernment organizations and other industries

Table I.
Innovation capability enablers from literature review

But on the other hand, the Indian MSME sector faces numerous challenges, such as insufficient skilled manpower, technological obsolescence, working capital shortages, not getting trade receivables from large and multinational companies on time, turbulent and uncertain market scenario, sub-optimal scale of operation, change in manufacturing strategies, supply chain inefficiencies and increasing domestic and global competition. Owing to these challenges, there is a need for MSMEs to adopt innovative approaches in their day-to-day operation. MSMEs that are inventive, creative, global in their business point of view and innovative and have a robust technological base, competitive strength or a willingness and ability to reconstruct, recreate or restructure themselves can only survive in the present dynamic business environment and come out successfully to contribute more in the nation's gross domestic product.

2.3 Definition of micro, small and medium enterprises in India

Every economy has their own criteria for defining MSMEs. Some defined MSMEs in terms of number of employees; some defined it in terms of annual sales and turnover, whereas some defined it in terms of investment in plant and machinery. In India, MSMEs are defined in terms of investment in plant and machinery by MSMED Act 2006.This act classified enterprises in two categories: one is manufacturing enterprises and the other is service enterprises (Table II).

3. Research methodology

In this paper, given methodology has been applied for evaluation and ranking the innovation enablers. This paper used the fuzzy analytical hierarchical process to get weights of criteria and prioritize to find the final rank. Fuzzy analytical hierarchical process (FAHP) is a multicriteria decision-making (MCDM) tool. By using the fuzzy concept, vagueness and uncertainty can be managed. This method is suitable in such a complex multicriteria decision environment. Figure 1 shows a graphic map of the proposed research methodology.

The proposed outline of this research work is illustrated through Figure 1. Initially, identification of IC factors was done through an in-depth literature analysis and followed by discussions with industrial experts. After that, pairwise comparison through a questionnaire are obtained for listed factors. Hereafter, specific factors are evaluated and respective weights of the factors are determined by using FAHP. If the weights are consistent, then they are approved, as shown through the symbol Y, where "Y" stands for yes. Otherwise, they are revised, as shown through the symbol N, where "N" stands for no. After that, factors are prioritized and analyzed further, as highlighted through the figure.

3.1 Fuzzy AHP

The AHP approach pioneered by Saaty (1980) is a mathematical approach of MCDM. AHP has some limitations in usability because of certainty and the subjective nature of the used scale. This problem can be minimized if AHP is integrated with the fuzzy concept (Garg, 2016; Prakash and Barua, 2016a, 2016b, 2016c, Prakash and Barua, 2015a, Prakash *et al.*,

Table II.
Definition of micro, small and medium enterprises

Enterprises	Manufacturing sector (investment in plant and machinery)	Service sector (investment in equipment)
Micro enterprises	Up to Rs 25 lakhs	Up to Rs 10 lakhs
Small enterprises	Rs 25 lakhs to 5 crores	Rs 10 lakhs to 2 crores
Medium enterprises	More than Rs 5 crores	Rs 2 crores to 5 crores

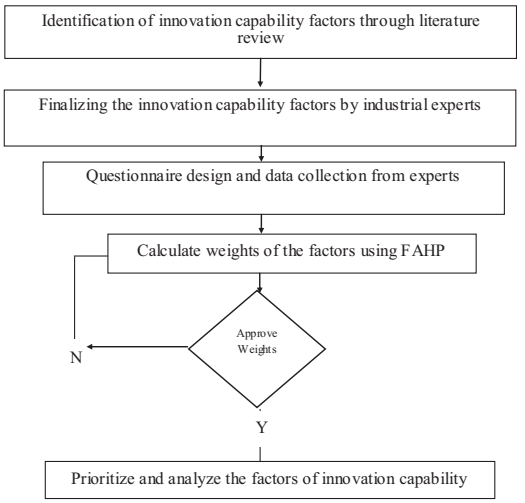

Figure 1.
Proposed FAHP methodology for innovation capability factors assessment

2015b). The fuzzy AHP methodology includes uncertainty and vagueness of the expert's judgments through linguistic variables. Various researchers have used this approach in different areas like urban planning, education, finance, transportation, politics, economics, marketing, logistics and reverse supply chain (Garg *et al.*, 2017; Kumar and Garg, 2017; Prakash and Barua, 2015c; Prakash *et al.*, 2015a, 2015b, 2014).

Chang's extent analysis (1992) presented the fuzzy AHP process; according to this approach, the values of extent method for each criterion are derived. The steps of Chang's analysis have been used. This approach was also used by Prakash *et al.* (2015a, 2015b, 2015c) and Prakash and Barua (2016b).

Step 1: The fuzzy synthetic extent value (E_i) with respect to the ith criterion is defined as:

$$E_i = \sum_{j=1}^{m} M_{g_i}^{j} \times \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^{j} \right]^{-1} \tag{3.1}$$

$M_{g_i}^{j} = 1, 2, 3, 4, 5 \ldots\ldots$, m are allotted triangular fuzzy number (TFN) presented in Table III.

Step 2: The possibility degree of $E_2 = (a_2, b_2, c_2) \geq E_1 = (a_1, b_1, c_1)$ is defined as below, where $a \leq b \leq c$.

$V(E_2 \geq E_1) = {}_{\beta \geq \alpha}^{sup}[\min(\mu_{S_1}(\alpha), \mu_{S_2}(\beta))]$ and α and β denote respective membership function value.

Linguistic variables	Assigned TFN
Equal	(1, 1, 1)
Very low	(1, 2, 3)
Low	(2, 3, 4)
Medium	(3, 4, 5)
High	(4, 5, 6)
Very high	(5, 6, 7)
Excellent	(7, 8, 9)

Table III.
TFN of linguistic comparison matrix

For comparison between E_1 and E_2, we need to determine $V(E_1 \geq E_2)$ and $V(E_2 \geq E_1)$.

Step 3: A convex fuzzy number E to be greater than l convex fuzzy numbers E_i ($i = 1, 2, \ldots, l$) can be defined by:

$$\begin{aligned} & V(E \geq E_1, E_2, \ldots\ldots, E_l) \\ & = V\left[(E \geq E_1) \text{ and } (E \geq E_2) \text{ and } \ldots\ldots \text{ and } (E \geq E_l)\right] \\ & = \min V(E \geq E_i), \qquad i = 1, 2, \ldots\ldots, l \\ & \text{Suppose that } p'(A_i) = \min V(E_i \geq E_l) \end{aligned} \tag{3.2}$$

For $l = 1, 2, \ldots, n, l \neq i$, and weight vectors are given in equation (3.3) as:

$$W' = \left(p'(A_1), p'(A_2), \ldots\ldots, p'(A_m)\right)^T \tag{3.3}$$

Step 4: After normalization, the normalized weight vectors can be obtained in equation (3.4) as:

$$W = \left(p(A_1), p(A_2), \ldots\ldots, p(A_m)\right)^T \tag{3.4}$$

3.2 Calculation of the value of fuzzy synthetic extent

The value of fuzzy synthetic extent is calculated from the fuzzy pair-wise comparison matrix (Table IV) by using the equation (3.1). For illustration purpose, the calculation procedure is demonstrated for the innovation enablers as discussed in Table I. Let fuzzy synthetic values with respect to seven IC factors be denoted by IC_1, IC_2, IC_3, IC_4, IC_5, IC_6 and IC_7:

$$\begin{aligned} IC_1 = \sum_{j=1}^{m} M_{g_1}^j &= (1, 1, 1) + (3, 4, 5) + (2, 3, 4) + (2, 3, 4) + (3, 4, 5) \\ &\quad + (0.333, 0.5, 1) + (3, 4, 5) \\ &= (14.333, 19.50, 25) \\ IC_2 &= (7.85, 10.08, 12.5) \\ IC_3 &= (5.95, 8.25, 10.83) \end{aligned}$$

Similarly, $IC_4 = (11.58, 15.58, 20.5)$, $IC_5 = (5.93, 8.25, 11)$, $IC_6 = (8.53, 12.75, 17.33)$ and $IC_7 = (5.85, 8.08, 10.5)$:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^j\right]^{-1} = \left[(60.03), (82.75), (107.7)\right]^{-1}$$

$$S_i = \sum_{j=1}^{m} M_{g_i}^j \times \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^j\right]^{-1}$$

Table IV. Fuzzy pair matrix for innovation capability enablers

	KM	RT	AP	CIM	ITM	OC	CO
Knowledge management (KM)	(1, 1, 1)	(3, 4, 5)	(2, 3, 4)	(2, 3, 4)	(3, 4, 5)	(0.333, 0.5, 1)	(3, 4, 5)
Risk-taking (RT)	(0.2, 0.25, 0.333)	(1, 1, 1)	(0.2, 0.25, 0.333)	(0.25, 0.333, 0.5)	(3, 4, 5)	(3, 4, 5)	(0.25, 0.333, 0.5)
Actor's participation (AP)	(0.25, 0.333, 0.5)	(3, 4, 5)	(1, 1, 1)	(0.2, 0.25, 0.333)	(1, 2, 3)	(0.25, 0.333, 0.5)	(0.25, 0.333, 0.5)
Creativity and idea Management (CIM)	(0.25, 0.333, 0.5)	(2, 3, 4)	(3, 4, 5)	(1, 1, 1)	(3, 4, 5)	(0.333, 0.5, 1)	(2, 3, 4)
Information and technology management (ITM)	(0.2, 0.25, 0.333)	(0.2, 0.25, 0.333)	(0.333, 0.5, 1)	(0.2, 0.25, 0.333)	(1, 1, 1)	(1, 2, 3)	(3, 4, 5)
Organizational culture (OC)	(1, 2, 3)	(0.2, 0.25, 0.333)	(2, 3, 4)	(1, 2, 3)	(0.333, 0.5, 1)	(1, 1, 1)	(3, 4, 5)
Collaboration (CO)	(0.2, 0.25, 0.333)	(2, 3, 4)	(2, 3, 4)	(0.25, 0.333, 0.5)	(0.2, 0.25, 0.333)	(0.2, 0.25, 0.333)	(1, 1, 1)

$$IC_1 = (14.333, 19.50, 25) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.133, 0.235, 0.416)$$

$$\text{Similarly } IC_2 = (7.85, 10.08, 12.5) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.072, 0.121, 0.208)$$

$$IC_3 = (5.95, 8.25, 10.83) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.055, 0.099, 0.180)$$

$$IC_4 = (11.58, 15.58, 20.5) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.107, 0.191, 0.341)$$

$$IC_5 = (5.93, 8.25, 11) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.055, 0.098, 0.183)$$

$$IC_6 = (8.53, 12.75, 17.33) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.079, 0.154, 0.288)$$

$$IC_7 = (4.1, 5.42, 7) * \left[(60.03), (82.75), (107.7)\right]^{-1}$$
$$= (0.054, 0.097, 0.174)$$

The degree of possibility of $IC_2 = (lC_2, m_2, u_2) \geq IC_1 = (IC_1, m_1, u_1)$is calculated by using equation (3.2):

$$V(IC_1 \geq IC_i) = 1, (i = 2, 3, 4, 5, 6, 7) \text{ and}$$
$$V(IC_2 \geq IC_1) = \frac{0.133 - 0.208}{(0.121 - 0.208) - (0.235 - 0.133)}$$

$$V(IC_2 \geq IC_1) = 0.397$$
$$V(IC_2 \geq IC_3) = 1, \text{ and } V(IC_2 \geq IC_4) = \frac{0.107 - 0.208}{(0.121 - 0.208) - (0.188 - 0.107)}$$
$$V(IC_2 \geq IC_4) = 0.591$$

Similarly, other calculations have been done by the same procedure, by using equations (3.2) to (3.4). V values are calculated are shown in Table V.

Then, we determined the minimum degree of possibility by using equation (3.2) as:

Table V. The V values and minimum value

	Degree of possibility						Min value
IC1 = (0.133, 0.235, 0.416)	IC1 > IC2 = 1	IC1 > IC3 = 1	IC1 > IC4 = 1	IC1 > IC5 = 1	IC1 > IC6 = 1	IC1 > IC7 = 1	1
IC2 = (0.072, 0.121, 0.208)	IC2 > IC1 = 0.397	IC2 > IC3 = 1	IC2 > IC4 = 0.591	IC2 > IC5 = 1	IC2 > IC6 = 0.80	IC2 > IC7 = 1	0.397
IC3 = (0.055, 0.099, 0.180)	IC3 > IC1 = 0.258	IC3 > IC2 = 0.829	IC3 > IC4 = 0.442	IC3 > IC5 = 1	IC3 > IC6 = 0.650	IC3 > IC7 = 1	0.258
IC4 = (0.107, 0.188, 0.341)	IC4 > IC1 = 0.824	IC4 > IC2 = 1	IC4 > IC3 = 1	IC4 > IC5 = 1	IC4 > IC6 = 1	IC4 > IC7 = 1	0.824
IC5 = (0.055, 0.098, 0.183)	IC5 > IC1 = 0.267	IC5 > IC2 = 0.826	IC5 > IC3 = 0.992	IC5 > IC4 = 0.449	IC5 > IC6 = 0.652	IC5 > IC7 = 1	0.264
IC6 = (0.079, 0.154, 0.288)	IC6 > IC1 = 0.656	IC6 > IC2 = 1	IC6 > IC3 = 1	S6 > S4 = 0.829	IC6 > IC5 = 1	IC6 > IC7 = 1	0.656
IC7 = (0.054, 0.097, 0.174)	IC7 > IC1 = 0.232	IC7 > IC2 = 0.808	IC7 > IC3 = 0.983	S7 > S4 = 0.418	IC7 > IC5 = 0.983	IC7 > IC6 = 0.629	0.232

$$m(KE) = minV(IC_1 \geq IC_k) = min(1, 1, 1, 1, 1, 1) = 1$$

$$m(RT) = minV(IC_2 \geq IC_k) = min(0.397, 0.931, 0.60, 1, 0.796, 1) = 0.397$$

$$\text{Similarly } m(AP) = 0.258,\ m(IM) = 0.824,\ m(ITM) = 0.267,\ m(OC) = 0.656,\ m(CO) = 0.232.$$

Then, the weight vector is given by:

$$W_p = (1,\ 0.397\ ,\ 0.258,\ 0.824,\ 0.267,\ 0.656,\ 0.232)^T$$

After normalization of W_p, we get final weight vectors as:

$$W = (0.275,\ 0.109,\ 0.070,\ 0.226,\ 0.073,\ 0.180,\ 0.063\ )^T$$

Final ranking is done for IC enablers in the descending order as shown in Table VI.

4. Results and discussions

Our results show the ranking of various innovation enablers by using fuzzy AHP. The prioritization of the IC factors has been done by observing the highest weightage value, which shows that KM with the weightage value of 0.25751 is the most important factor that helps in enhancing the IC of the MSME sector. In the current business scenario, organizations, especially MSMEs, are fighting for their survival. To be innovative at local, national and global markets, there is a need to develop and enhance organizations' capabilities. For that, KM must be an integral part of developing and enhancing the ICs of MSMEs, as KM includes the improvement of knowledge generation or transfer through knowledge acquisition, assimilation and dissemination. Knowledge can be enhanced by sharing it within and outside an organization. Knowledge sharing means collecting and donating knowledge, which can be done by capturing, managing and transferring based on experience that exists within an organization (Lin, 2007). The second important factor for developing IC in MSMEs is creativity and idea management (CIM). In MSMEs, there is a need to drive some combination of creative ideas and the ability for their execution. No doubt, the present business environment is dynamic and multifaceted. This scenario demands improved dynamism of approach. Only the organizations that are discerning are able to handle and manage the changes that are inherent in the current business

Table VI.
Final ranking of innovation capability enablers

Innovation capability enablers	Final weights	Rank
Knowledge management (KM)	0.275179	1
Risk-taking (RT)	0.109246	4
Actors participation (AP)	0.070996	6
Creativity and idea management (CIM)	0.226747	2
Information and technology management (ITM)	0.073473	5
Organizational culture (OC)	0.180517	3
Collaboration (CO)	0.063841	7

environment. So, it is very important to manage the ideas effectively and efficiently in the MSME sector. Based on the weightage value, OC is the third most important factor that helps in generating and developing ICs. Martinez-Roman *et al.* (2011) claim cross-functional communication and hierarchical power and reward system, whereas Smith *et al.* (2008) highlight the importance of level of decentralization as the determinants of IC, which constitutes OC. At the fourth place, risk-taking (RT) with the weightage value of 0.109246 plays an important role in the process of innovation. Generally, RT is considered as a negative concept. No doubt, some risks are not fruitful but some are well paid off. RT ability leads to learning about new things, approaches, attitude and thinking. RT does not mean doing things without planning; the chances of success will be more if an entrepreneur takes calculated risk. Innovation means developing new things, and RT is also associated with newness and unexplored things, which means without risk, an organization will not generate innovations. Information and technology management (ITM) is at the fifth place with the weightage value of 0.073473. Participation of the actors (customer, suppliers and employees), which stood at sixth rank, is another important factor for enhancing the ICs in the MSME sector. The last factor identified for enhancing the IC of MSMEs is collaboration (CO). Collaboration means working together for the benefit of the team or organization. In a healthy team, every entity is connected and shares a relationship of cooperation. Innovation is a result of sharing of organizational resources, knowledge and time. In many research and development activities, enterprises have to be involved with other organizations and go for interorganizational agreement in the field of research. Only those industries that are active in collaborating with the universities, research institutes and other industries can easily achieve innovation. Other factors for innovation like RT and knowledge enhancement require the ability to change according to different situations. This factor prepares entrepreneurs to perform in a highly dynamic environment with the support of other entities as well. Generally, innovation is considered to be a solution to a problem that requires quick thinking, shifting priorities and going for an alternative course of action.

5. Sensitivity analysis and managerial implications

Among all categories of enablers, the creative environment enabler receives the highest priority weight. This enabler ranked as the highest among the other enablers carries the potential to influence other enablers. Hence, it is recommended to test the final ranking by varying the weights of all enablers (Vishwakarma *et al.*, 2015, 2016a, 2016b; Prakash and Barua, 2016a). To illustrate the sensitivity analysis, the effect of an incremental change in value from 0.1 to 0.9, to KM, was determined, as shown in Table VII. The results of the sensitivity analysis indicate that the maximum relative change happened in KM (for details, please see Table VII and Figure 2). Further, owing to variation in the enabler weights, the

	Knowledge management values in performing the sensitivity analysis test									
Identified enablers	0.1	0.2	Normalized (0.2751)	0.3	0.4	0.5	0.6	0.7	0.8	0.9
KM	6	2	1	1	1	1	1	1	1	1
RT	3	4	4	4	4	4	4	4	4	4
AP	5	6	6	6	6	6	6	6	6	6
CIM	1	1	2	2	2	2	2	2	2	2
ITM	4	5	5	5	5	5	5	5	5	5
OC	2	3	3	3	3	3	3	3	3	3
CO	7	7	7	7	7	7	7	7	7	7

Table VII. Ranking for specific factors by sensitivity analysis when knowledge management varies

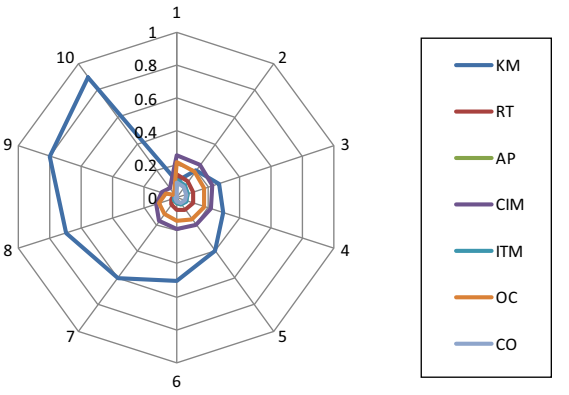

Figure 2.
Results of sensitivity analysis

specific enabler weights and their final ranking also varied. In sensitivity analysis, when creative environment enabler value is 0.1, the first rank is acquired by KM, whereas CO holds the last rank. Facto KM holds highest rank until the value of KM reaches to the value (i.e. 0.200). At normalized level, when KM value is 0.2751, then same enabler KM gets first rank and factor CO continues to obtain the last rank. From this point, KM values varied from 0.3 to 0.9, the first rank is acquired by knowledge management, however first rank is obtained by itself and the ranks of other enablers vary in the same manner (for details, please see Table VI and Figure 3). At this instance, it may be concluded that KM is very important in adopting and managing and enhancing the IC of MSMEs and, so, needs greater managerial concentration. If the managers are able to manage the KM factor and its related concerns in an effective manner, it will be quite useful in maintaining and implementing the innovation in MSMEs.

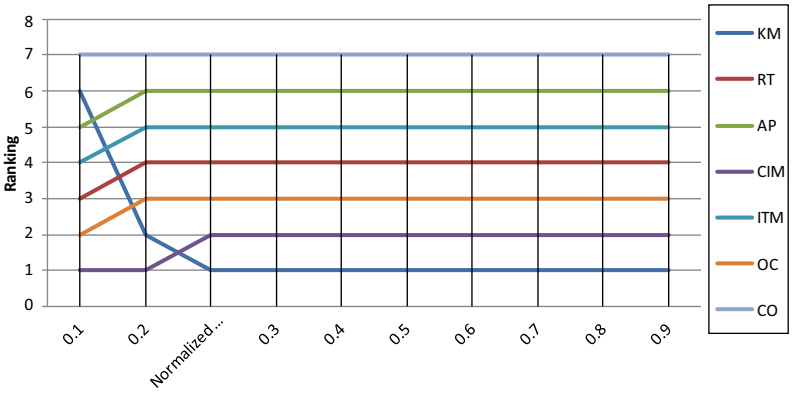

Figure 3.
Ranking of enablers obtained in sensitivity analysis run

Implications of our study rest on understanding the importance of various enablers of IC in MSMEs and the manner in which enablers influence the capability to innovate. For entrepreneurs, enhancing the innovation begins with a clear and specific definition of the strategy of the firm. Entrepreneurs and policymakers should consider the various opportunities to develop the innovation to achieve the desired results (Tables VII and VIII).

This finding highlights the fact that MSME entrepreneurs in India must possess necessary knowledge and skills with the help of which they acquire essential resources, including being able to take calculated and informed risk and to develop innovative and creative solutions, remain aware of government initiatives and must possess the ability to sense future changes in the market. The importance of KM for developing IC is also highlighted by Al-Ahbabi *et al.* (2017) and Hussein *et al.* (2016).

6. Conclusions

Enhancing the IC of MSMEs is a very complex and crucial process. In this study, we have explored the factors that act as a catalyst for ICs in MSMEs. In today's dynamic and multifaceted business environment, it is very imperative to enhance the performance of MSMEs so that they can offer a more innovative product and service that can compete with that offered by its global competitor. However, the question is how MSMEs can identify which factor is important for developing their capability to innovate. For that, it is very imperative to prioritize the factors influencing the IC of an organization. This study presents prioritization of the IC factors by identifying the enablers based on literature, industry experts and industry associates. Our study has confirmed the complexity and importance by prioritizing the various enablers of IC, especially in MSMEs. In addition to the identification of various factors enhancing IC, our results give the ranking to all the enablers. The priority-wise concern for the results of our study highlights several factors that would help entrepreneurs and policymakers to enhance innovation and researchers/scholars to better channelize their efforts to understand and study the phenomena.

6.1 Limitations and scope of future work

We have used the fuzzy AHP approach for prioritizing the factors influencing IC to improve the performance of Indian MSMEs. All pair comparisons in fuzzy AHP have been assigned by experts. From the relevant literature and experts' views in detail, other IC enablers can be identified and ranked. As it is natural, views of decision-makers may be subjective and vary. Different MCDM approaches may be applied using several approaches such as analytic network process, interpretative structure modeling, interpretative ranking process, decision-making trial and evaluation laboratory and multiple attribute utility theory for the similar problem and outcomes/results can be matched in the further studies.

Table VIII. Weights for specific enablers by sensitivity analysis when knowledge management varies

	Knowledge management (KM) enabler values in performing the sensitivity run									
Identified enablers	0.1	0.2	Normalized (0.2751)	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RT	0.138	0.122	0.109	0.105	0.088	0.072	0.055	0.028	0.016	0.010
AP	0.100	0.084	0.071	0.067	0.050	0.034	0.017	0.013	0.009	0.001
CIM	0.256	0.239	0.227	0.223	0.206	0.189	0.173	0.127	0.093	0.069
ITM	0.103	0.086	0.073	0.069	0.053	0.036	0.019	0.013	0.010	0.001
OC	0.210	0.193	0.181	0.176	0.160	0.143	0.126	0.110	0.067	0.019
CO	0.093	0.076	0.064	0.060	0.043	0.026	0.010	0.008	0.005	0.000

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