Multilevel analysis of factors influencing innovation through m-TISM approach

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Abstract: This paper explores the factors affecting innovation at three distinct levels – firm, industry and country level and analyses the relationship amongst the factors in each level. The list of factors has been identified through literature search and further using inputs from academicians, practitioners and policymakers' contextual relationship amongst the factors that have been studied. Modified total interpretive structural modelling (m-TISM) has been utilised to examine the driving and dependence power of factors at each level and develop a hierarchical model. Overall, this paper analyses 14 factors affecting innovation across firm, industry and country level. Results show that antecedents such as knowledge acquisition, research and development at the organisational level have high driving power and significant impact on innovation as knowledge itself serves as the basis of innovation, and business sophistication is an important factor for enhancing innovation capacity and economic growth at a country level. Furthermore, organisational encouragement and quality of human resources are important factors that promote creativity and innovation at the industry level. Entrepreneurs, academicians and government can focus on the factors identified and define strategies for enhancing innovation in the organisations or in the country.

Keywords: innovation; modified total interpretive structural modelling; m-TISM; MICMAC analysis; firm; industry; country.

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1 Introduction

In the present global economic environment, it is necessary to continuously innovate in order to sustain the business. Major global corporations like ENRON and COMPAQ that were proud members of the Fortune 500 club no longer exist. In the fast-changing global technological environment, technologies and concepts are becoming irrelevant at an increasing pace. The lack of studies and research in this area limits the consideration of exactly why and how various factors affect individual- and multi-level innovation. Creativity is considered to be a critical individual-level factor affecting innovation (Pratoom and Savatsomboon, 2012; Woodman et al., 1993). Creativity is not adequate enough for developing innovation (Anderson et al., 2004). People must be driven to persevere and face the challenges in the field of creative work (Gilson and Shalley, 2004).

Porter (1998) famously said, "The innovation point is the pivotal moment when talented and motivated people seek the opportunity to act on their ideas and dreams". It is a global phenomenon, which has been researched and studied by various authors at multiple levels. The 10th edition of the Global Innovation Index ranked India at the 60th position out of 127 countries that were involved in the study. India's drive towards development with programmes like 'Make in India' and 'Start-up India' are intended to be driven by innovation; therefore, it is necessary to understand how the innovation levels in the country can be increased to catalyse the growth phase of India. In a survey by IBM Institute for Business Value, 2017, in collaboration with Oxford Economics, 77% of venture capitalists believe that a considerable number of Indian start-ups lack ground-breaking innovation based on unique business models or new technologies. It was noticed in the survey that many start-ups emulate existing globally successful ideas. In addition, the literature on general management suggests that organisations should work on their innovation strategies to effectively deal with competition (Chatterji et al., 2014; Lengnick-Hall, 1992; Porter, 1990; Roberts, 1998).

Technologies like polaroid and pager are no longer in existence suggesting that innovation undertaken once may not sustain forever and it is an iterative process. Innovation strategies depend not only on a company's workforce and technology, but also on the environmental factors, R&D activities and innovation level (Genis-Gruber and Öğüt, 2014; Ngibe and Lekhanya, 2019; Park and Bae, 2018). Previous case studies have shown that individuals scoring high on self-leadership skills will do well as innovative entrepreneurs (Genis-Gruber and Öğüt, 2014; Guzman et al., 2020; Koellinger, 2008). It is noted that self-leadership skills are effective at individual level and help foster individual-level innovation (Carmeli et al., 2006; Javed et al., 2019; Xerri and Brunetto, 2013). A firm's knowledge management indirectly affects the creativity and innovation at an individual level (Aulawi et al., 2009; Muhammed et al., 2008; Podrug et al., 2017; Yeşil et al., 2013). The story of innovation has seen extraordinary changes in the last few years in view of a set of factors, including the advancement of technology and science and the exponential increase in the globalisation of markets and related activities. Similarly, the acceleration of globalisation at most economic and social levels has amplified the need to take advantage of firms at an international level as well as exploring new technologies on an international platform. Specialised research has reached a common conclusion that various features have an influence on the organisational modes of innovation activity. With regards to the success factors for affecting innovation, some studies consider the factors independent from one another (Sharma et al., 2019; Smith et al., 2019; Van der Panne et al., 2003; Zheng, 2010). In this paper, we argue that the factors are interrelated and co-dependent; therefore, innovation needs to be studied in a holistic manner. In the present research, our aim is to study various factors that affect innovation at the organisation, industry and country levels and construct a model on the basis of their driver and dependent relationship. The main objectives of this study are as follows:

1. to identify the factors that affect innovation at three levels, i.e., organisation, industry and country
2. to study the interrelationship and interdependence of these factors by developing modified total interpretive structural modelling (m-TISM)
3. to identify the driving and dependence power of the identified factors with the help of MICMAC analysis.

In the following section, we identify the various factors affecting innovation at multiple levels through extant Section 2 review of the literature. Section 3 discusses the methodology and the analysis using TISM and m-TISM for the identified factors; Section 4 presents the MICMAC analysis; Section 5 includes the results and discussion and Section 6 presents the conclusion, limitations and implications of the study.

2 Literature review

The challenges being faced by organisations to maintain their competitiveness in the market can be tackled by boosting their innovation drive. In the literature, multiple models are proposed to understand the relationships between innovation and firm/industry performance. At the conceptualisation phase of any research, we encounter key questions such as what, how, why, when, where and who (Sutton and Staw, 1995; Whetten, 1989). Out of these questions, 'what' and 'how' can be answered by developing an interpretive structural model (Warfield, 1974). The answer to the question 'why' can be found by adopting the total interpretive structural model (Hasan et al., 2019; Parameswar et al., 2020; Rajan et al., 2021; Sushil, 2012, 2018).

From the literature, it has been observed that innovation is affected by multiple factors, from an individual to a global level. A simple term such as 'innovation', is merely a summed outcome of multiple supporting factors. At every level, different factors affect innovation, from an individual to a global level. To maintain the factors affecting innovation at a macro scale throughout this paper, focus is maintained on the firm-, sector- and country-level factors. To understand the factors affecting innovation at the firm level, the research by Alvaro Gómez and José Luis, 2011 is focused upon. Their paper studies various models to understand innovation behaviour; therefore, these factors can be utilised in the Indian perspective. The paper concludes with the importance of information management and the lesser impact of contingent factors and organisational resources.

2.1 At the organisational level

The current research has taken into consideration the age of the firm, size of the firm, leadership of the firm, research and development activities undertaken and knowledge acquisition.

2.1.1 Firm size

The relationship between the firm size and innovation has been researched by many scholars (Calvo, 2006; Coad et al., 2013; Vrontis et al., 2021; Zhang et al., 2020). While some authors support a positive impact of this relationship (Moch and Morse, 1977), others support a negative impact (Acs and Audretsch, 1987). The firm size is based on the human capital the firm owns. Human and organisational resources directly impact the ability of an organisation to innovate (Acs and Audretsch, 1987). Yi et al. (2019), show that an increase in firm size raises the probability of product innovation success. Large firms are more innovative, specifically in R&D activities (Schumpeter, 1950), whereas small firms mostly focus on minor or marginal innovations, which remain unnoticeable in the market (Dey et al., 2017). Moreover, small firms are found to be more innovative, as they have high patent counts and citations per dollar of R&D than larger firms (Plehn-Dujowich, 2009).

2.1.2 Firm age

It takes into consideration the year of establishment of the organisation. The national innovation survey shows that newer firms have lesser innovativeness, while older firms show more innovativeness. Firm age is negatively related to technical quality, which, in turn, affects innovation (Balasubramanian and Lee, 2008). These papers form the basis for considering the factors affecting innovation at the firm level. Huergo and Jaumandreu (2004), studied the impact of firm age on innovation and suggest that the quality of a firm's innovation changes over time and across industries as they gain experience. Sørensen and Stuart (2000), explained fundamental age effect as follows: because of their well-developed technological orientations, older firms have better exploitative innovations rather than explorative ones as they age. Most of the earlier studies on firm age and innovation emphasised on liability to newness, although some studies have found that the relationship between the two is mixed as it also depends on the context of the firm (Anderson and Tushman, 1990; Le Mens et al., 2011).

2.1.3 Firm leadership

It takes into consideration the type of ownership the firm has. Leadership can promote an organisation's innovativeness by building a flexible environment where employees can openly share their viewpoints (Tang, 2006). The major role of a leader in creating innovation is to motivate their organisational members to learn continually and update their skills (Senge, 1990). Previous studies support the finding that innovative leaders affect innovation outcomes in organisations (Bulińska-Stangrecka and Bagieńska, 2018; Lesáková et al., 2017). Strategic leaders have a significant impact on technological innovation (Cannella et al., 2009), and they determine organisational outcomes in general and innovation in particular (Hambrick et al., 1984). Research indicates a fundamental relationship between the behaviour of the leader who adopts the idea of the subordinate's freedom of action and the subordinate's ability to think creatively (Mohammed, 2020; Rassa and Emeagwali, 2020), as well as the positive relationship of the laissez-faire style of leadership with administrative creativity of the employees. According to Martins and Terblanche, 2003, leadership contributes to an organisational culture that, in turn, affects innovation by practising deep-held organisational values, beliefs and behaviour. In addition, innovative leaders own this ability to maintain a balance between creativity and discipline (Bel, 2010).

2.1.4 Knowledge acquisition

It is the merger of the technological resources of the firm along with knowledge and information management. Innovation is an interactive process in which the company acquires knowledge through its design, production and constant learning through its relationship with external sources (Freeman, 1999). Newer firms have been noted to mostly acquire technology from external sources in form of patents, while the older firms mostly acquire knowhow of the technology. Studies shows a significant relationship between knowledge acquisition and innovation in businesses as well as the potential of small firms to move ahead of traditional practices (Darroch and McNaughton, 2002; Kristiansen and Bloch-Poulsen, 2010). Knowledge management can further guide firms on how to deal with competitive business environments (Huang et al., 2013). The process of innovation in general refers to something new, i.e., knowledge acquisition (Chen et al., 2010). Turulja and Bajgorić (2018) confirm the mediating effect of innovation between organisational business performance and both knowledge application and knowledge acquisition.

2.1.5 R&D activities

They are essential for technological innovation as per the Oslo Manual. Research and development are not considered as a prerequisite for innovativeness, but it can positively contribute to the innovation process (Kline and Rosenberg, 1986). R&D activities usually involve working on unknown research targets. Innovative firms are willing to not only take high risks when required, but also pay for the cost of R&D failures; thus, they reduce their expected profits (Czarnitzki and Kraft, 2010). Czarnitzki and Kraft (2010), explain that R&D activities help firms in creating stochastic innovations that increase profits, and in turn, a firm's investment in R&D helps in understanding its profitability. Furthermore, Czarnitzki and Kraft (2010), studied patent and R&D activity data and found a significant relationship between firm profitability and innovative behaviour.

2.2 At the industry level

Jegede et al. (2012) studied the factors affecting innovation and competitiveness in the service sector. The study takes into perspective the internal and external factors that affect an industry. External factors comprise the market, government and society, while internal factors comprise the people, structure and strategy. In addition, research conducted in Chinese firms on the factors that affect innovation in logistics technologies has taken into consideration internal and external factors. Internal factors included the quality of human resources and organisational encouragement and external factors included governmental support and environmental uncertainty (Jegede et al., 2012).

2.2.1 Quality of human resources

Leadership behaviour and quality of human resources of the higher management will significantly influence innovation (Tornatzky et al., 1990). The external environment takes into consideration the pressure that comes from competitors, and the role of government also affect innovation (Scupola, 2003). The quality of the human resources can be understood from the extent of organisational learning and the proportion of staff assigned to R&D (Scupola, 2003). Few studies emphasised the importance of innovation in quality circles whereas highlight the role of developing quality circle in production firm that will help in resolving various issues related to quality of technological process (Blaga and Jozsef, 2014; Romijn and Albaladejo, 2002). Innovative firms follow different policies and practices in comparison to the firms that follow traditional strategies like quality enhancement and reduction in cost (Schuler, 1989). Also relative to non-innovative firms, when it comes to innovative firms focus is given more on managerial expertise while recruiting managers by offering lucrative packages and high standards performance appraisals (Martell and Carroll Jr, 1995).

2.2.2 Organisational encouragement

The researchers suggest that more organisational encouragement results in more opportunity to adopt innovation. Similarly, higher the quality of human resources, better are the chances of the development of innovation. Researchers have stated that managerial skills and organisational encouragement for innovation further help in improving innovation (Amabile, 1988; Damanpour and Aravind, 2012; Gupta et al., 2007; Perry-Smith and Mannucci, 2017; Scott and Bruce, 1994). Organisational encouragement promotes creativity through fair judgement and highlights the generation of unique ideas (Pirola-Merlo and Mann, 2004). Moreover, organisational encouragement of creativity and team climate for innovation affect creativity of the team and its members.

2.2.3 Environmental uncertainty

It was noticed that environmental uncertainty and complexity affect organisational innovation (Kimberly and Evanisko, 1981). Highly uncertain environments would directly impact organisational innovation and structure (Kimberly and Evanisko, 1981). Environmental uncertainty provides the much-needed incentive to the firm to incorporate new technologies (Zhu and Weyant, 2003). High levels of environmental uncertainty are positively related to high levels of innovation (Martínez-Román et al., 2011; Russell, 1990). The ability of an organisation to manage its environmental uncertainty will significantly affect its innovativeness and performance (Montes et al., 2004), Furthermore, environmental uncertainty influences both the magnitude and the nature of innovation (Damanpour, 1996). Although less research is available to understand the effects of environmental uncertainty on innovation (Damanpour, 1996), previous studies have suggested that a firm's innovation is dependent on its internal as well external environment (Levinthal and March, 1993). In addition, research shows that with an increase in external environmental uncertainty, the innovation level of the firm increased (Aiken and Hage, 1971; Damanpour, 1996; Nystrom et al., 2002).

2.2.4 Governmental support

On the other hand, governmental support can have a positive or negative impact. Through regulation, the government can discourage or encourage the implementation of innovation (Lai et al., 2005; Tornatzky et al., 1990). Its support plays a key role in encouraging innovation performance of firms (Guan and Yam, 2015; Herrera and Nieto, 2008). Previous studies on innovation confirms the role of governments in innovation performance and private R&D spending (Xu et al., 2014; Zúñiga-Vicente et al., 2014). Firms receiving both R&D grants and tax credits are considered to be more innovative in comparison to those receiving only tax credits (Zúñiga-Vicente et al., 2014).

At the country level, a yearly study of global innovation is conducted by the Global Innovation Index in each country. In 2017, 127 countries were a part of this study (GII, 2020). They have considered the innovation efficiency ratio based on the institutions, human capital and research, infrastructure, market sophistication and business sophistication.

2.2.5 Institutions

They include the governance, political environment and regulatory environment and the World Bank indices of ease of doing business of a nation. Factors such as the possibility of destabilisation of the government and quality of public and civil services are considered. In addition, institutional environment plays a very important role in determining the innovation of the firms (North, 1990); for example, lack of intellectual property rights may hamper innovation. Hirshleifer et al. (2012) confirmed that firms with overconfident CEOs are more willing to work on challenging projects and promote innovation. Furthermore, Zacchia (2020) explained that when different firms work together, it often leads to innovation by process of knowledge sharing. He and Tian (2013) asserted that innovation is also hindered when firms work under financial analysts as they prioritise meeting short-term goals rather than focussing on innovation strategies.

2.2.6 Human capital and research

It focuses on the education, government expenditure per pupil, performance of students at different levels of education, coverage, expenditure and success of RandD firms. Studies have shown a strong significant relationship between innovation and human capital. Furthermore, they have found a positive effect of trust and associational activity on innovation (He and Tian, 2013). Researchers have emphasised the role of human capital and institutions in innovation as well as in making national policies of innovation development (Kwan and Chiu, 2015).

2.2.7 Infrastructure

It takes into consideration the ICT, general infrastructure and ecological sustainability. Minimising the infrastructure gap and raising government capacity would help in developing an environment of innovation as well as contribute to the economic growth of developing countries. Karlsson (1997) confirms the significance of developing innovation networks and building infrastructure in product development. Infrastructure is defined by The World Bank as a measure of evaluating a nation's competitiveness (Schwab and Sala-i-Martin, 2011; World Bank Group, 2018). Furthermore, fast-changing economic environments help in developing innovative and creative ideas. Research has shown the importance of infrastructure in promoting economic development. Other studies have shown that there is a significant relationship between innovation and overall economic development at national or regional levels (Fagerberg et al., 2010; NESTA, 2009).

2.2.8 Market sophistication

It determines whether the market is investment worthy. Factors like ease of obtaining credit, lending laws, indicators to measure if market size is matched by market dynamism, competition and market scale (GDP) are considered as significant measures of the Global Innovation Index (GII, 2020). Czarnitzki and Hottenrott (2011) emphasised that focusing on new knowledge is a crucial factor in the creation of wealth. Furthermore, governments may further help firms to work on their innovation activities through subsidies. A study by Czarnitzki and Hottenrott (2011), shows that innovation helps in increasing the production potential, employment and economic growth. Kirikkaleli and Ozun (2019) further confirmed the role of small and large firms in the economic development of the country in addition to innovation.

2.2.9 Business sophistication

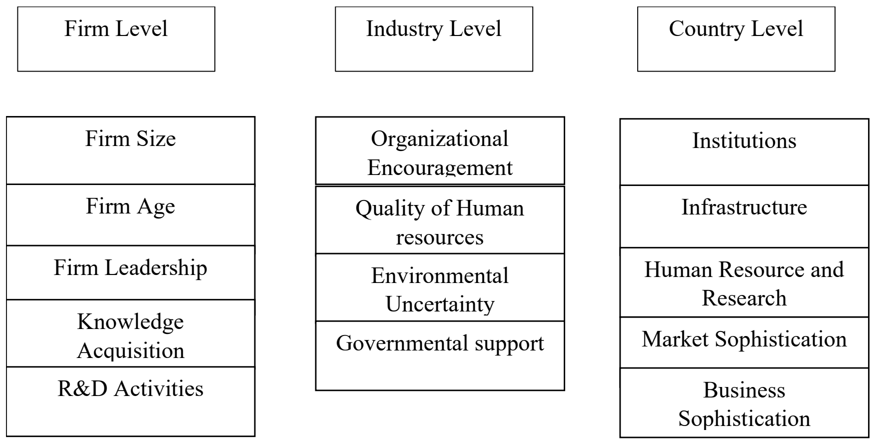
It is a factor to understand how firms encourage innovation. Enhancement in business sophistication enhances innovation capacity and helps in macroeconomic stability. Business sophistication and innovation capacity are significantly and positively related to each other. Galindo and Méndez (2014) examined the relationship between business sophistication, macroeconomic factors and innovation. Furthermore, Pece et al. (2015)

confirmed a positive relationship between innovation and economic growth. Dima et al. (2018) studied how knowledge economy affects a country's competitiveness in the European Union. Their study confirms that innovation with education is the major antecedent of economic convergence. Figure 1 and Table 1 present all the factors categorised into organisation-, industry- and country-level groups.

Table 1 List of factors affecting innovation at organisation, industry and country level

	Factor code	*Factor*	*Relevant literature*
Organisational level	C1	Firm size	Calvo (2000), Moch and Morse (1997), Audretsch and Acs (1987), Hurley and Hult (1998) , Schumpter (1950), Dey (2017), Fang et al. (2019) and Plehn-Dujowich (2009)
	C2	Firm age	Balasubramanian and Lee (2008), Huergo and Jaumandreu (2004), Sørensen and Stuart (2000), Anderson and Tushman (1990), Le Mens et al. (2011) and Methe et al. (1996)
	C3	Firm leadership	Tang 1999), Senge (1998), Lesáková et al. (2017), Bulinska-Stangrecka (2018), Finkelstein et al. (2009), Hambrick et al. (1984), Shaqqaa (2003), Zanati (1994), Martins and Terblanche (2003) and Bel (2010).
	C4	Knowledge acquisition	Freeman (1998), Darroch and McNaughtan (2002), Kristiansen et al (2005), Huang (2011), Chen (2010) and Turulja and Bajgorić (2018).
	C5	Research and development	Kline and Rosenberg (1986), Czarnitzki and Kraft (2010, 2014) and Warusawitharana (2015)
Industry level	C1	Organisational encouragement	Amabile (1988), Pirola-Merlo and Mann (2004)
	C2	Quality of human resources	Tornatzky and Fleischer (1990), Sherwood (1993), Blaga and Jozsef (2014), Schuler (1989) and Martell and Carroll (1995).
	C3	Environmental uncertainty	Scupola (2003), Evanisko (1981), Damanpour (1991), Zhu and Weyant (2003), Russell (1990), Montes et al. (2004), Freel (2005), Levinthal and March (1993), Damanpour (1996), Aiken and Hage (1971) and Nystrom et al. (2002).
	C4	Governmental support	Tornatzky and Fleischer (1990), Lai et al., (2005), Herrera and Nieto (2008), Xu (2014), Zúñiga-Vicente (2014) and Bérubé and Mohnen (2009).
Country level	C1	Institutions	North (1990), Zacchia (2019), He and Tian (2013) and Hirshleifer et al. (2012).
	C2	Infrastructure	Karlsson (1997), World Bank. (1994, 1996), World Economic Forum (2012), NESTA (2009).
	C3	Human capital and research	Dakhli and Clercq (2004) and Kwan and Chiu (2015)
	C4	Market sophistication	Kulkarni (2019), Czarnitzki and Hottenrott, (2009), Takalo et al. (2013) and Malecki, (2018).
	C5	Business sophistication	Kirikkaleli and Ozun (2019), Galindo and Méndez (2014), Pece (2015) and Dima (2018).

Figure 1 Conceptual model of various levels and factors affecting innovation at organisation, industry and country level



3 Methodology

The factors extensively researched and evaluated are similar to a mental model, which is articulated into a concept by understanding each level of innovation and utilising the total interpretive structural model. The analysis of what factors affect innovation, how they affect and why they affect should be analysed.

The 'what' and 'how' of the impact can be studied by developing an interpretive structural model as proposed by Warfield (1974). The 'why' of the effect can be studied by the usage of TISM, as refined and extended by Sushil (2012). What factors affect innovation have been determined by careful secondary research of previous studies on innovation and mind mapping. Figure 2 presents the step-by-step description.

3.1 TISM process

3.1.1 Step I: identifying and defining the elements

First, for a structural modelling exercise, the elements whose relationships are to be modelled are defined and identified.

Firm age, firm leadership, firm size, knowledge acquisition, research and development are the factors focused upon in the paper based on their prominence in various studies on innovation. Industry-level innovation is comprehensive, leading to a bifurcation into external and internal factors. Multiple factors have been consolidated into organisational encouragement and quality of human resources, which are mostly internal factors, while governmental support and environmental uncertainty are external factors. A more macro view is considered in the evaluation of country-level innovation. The availability of educational and research institutes, business sophistication, infrastructure, human capital and research and market sophistication are focused upon for evaluation. The framework for the factors is collated for each of the levels (Table 2).

Figure 2 Flow diagram of TISM model (see online version for colours)

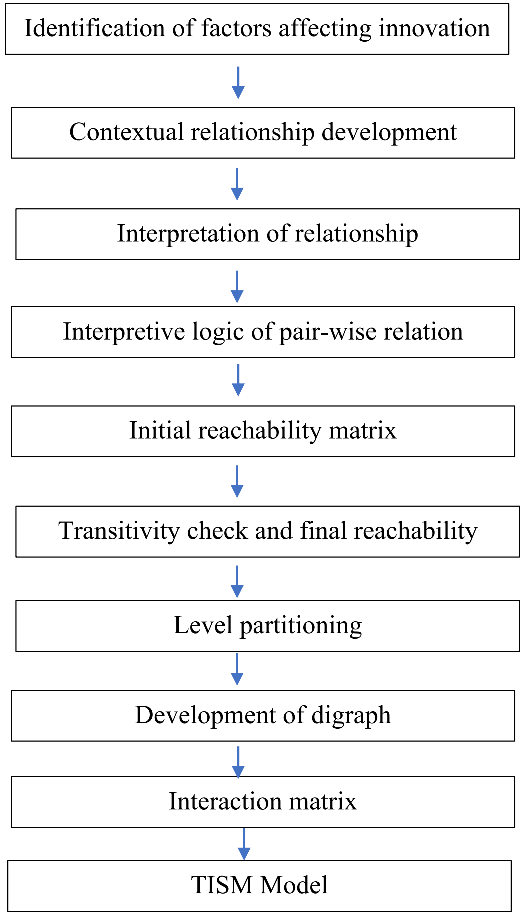


Table 2 Factors identified for each level along with their codes

	Factors		
Codes	*Organisation level*	*Industry level*	*Country level*
C1	Firm size	Organisational encouragement	Institutions
C2	Firm age	Quality of human resources	Infrastructure
C3	Firm leadership	Environmental uncertainty	Human capital and research
C4	Knowledge acquisition	Governmental support	Market sophistication
C5	Research and development (R&D)		Business sophistication

3.1.2 Step II: describing the contextual relationship between the elements identified

For the development of the model, the contextual relationships between the elements are defined. Only when the contextual relationship of the factors is outlined, can the structure, intent, attribute enhancement, priority, process and other details be understood and analysed. For example, factor 2 firm age will influence or enhance factor 3 firm leadership. This is conducted by usage of expert opinions and the TISM questionnaire to form a basis for the ideas.

3.1.3 Step III: defining the interpretation of the contextual relationships

At this stage, the traditional ISM shifts towards TISM. Although the contextual relationships are sufficient to understand the nature of the relationship, it is not adequate to interpret how the relationship works. Therefore, at this level, the nature of the relationship is to be clarified by interpreting it. This explains the way in which factor i influences factor j. The interpretation is specific for each pair i–j and j–i to uncover the deep-rooted knowledge.

3.1.4 Step IV: interpretive logic of pair-wise relation

In ISM, only the direction of the relationship is focused upon. To upgrade to TISM, interpretive matrices are used to fully interpret each pair of factors. Each link among the factors is categorised as yes (Y) or no (N), after which the relationship is modelled for further analysis and interpretation (Attached in appendix).

3.1.5 Step V: preparation of reachability matrix and transitivity check

The 'how' of these factors is considered by construction of the full transitive reachability matrix, which can be derived by paired comparison of the factors with a parallel transitivity check. The interpretive logic is converted to reachability matrix, where each Y is entered as one and N as zero in the matrix. The matrix is checked for the transitivity rule. For each transitivity lapse, either the expert opinion is to be considered to understand the reason of the lapse or the lapse is updated by a change from No to Yes, and the interpretation column is updated as transitive.

Table 3 Reachability matrix for innovation (organisational level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	1	0	1	1	0
C2	1	1	1	0	1
C3	1	0	1	0	1
C4	0	0	0	1	1
C5	0	0	0	1	1

Table 4 Reachability matrix for innovation (industry level)

	C1	*C2*	*C3*	*C4*
C1	1	1	0	0
C2	1	1	0	0
C3	1	0	1	1
C4	0	1	1	1

Table 5 Reachability matrix for innovation (country level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	1	1	0	1	1
C2	1	1	1	0	0
C3	0	0	1	1	1
C4	0	0	1	1	1
C5	0	0	0	0	1

Table 6 Reachability matrix with transitivity for innovation (organisational level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	1	0	1	1	1*
C2	1	1	1	1*	1
C3	1	0	1	1*	1
C4	0	0	0	1	1
C5	0	0	0	1	1

Table 7 Reachability matrix with transitivity for innovation (industry level)

	C1	*C2*	*C3*	*C4*
C1	1	1	0	0
C2	1	1	0	0
C3	1	1*	1	1
C4	1*	1	1	1

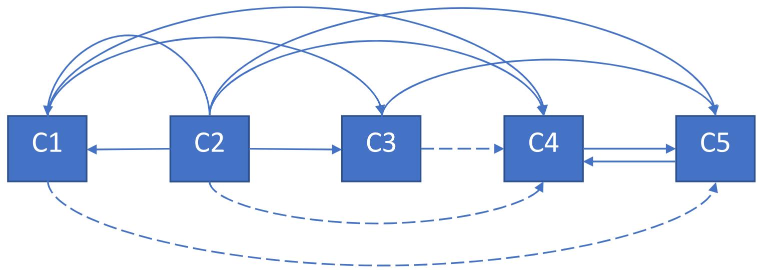
Table 8 Reachability matrix with transitivity for innovation (country level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	1	1	1*	1	1
C2	1	1	1	1*	1*
C3	0	0	1	1	1
C4	0	0	1	1	1
C5	0	0	0	0	1

3.2 m-TISM process

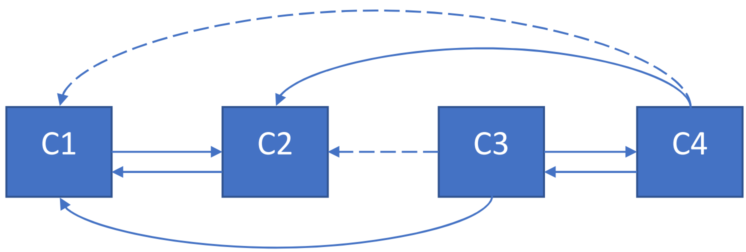
The steps of the traditional TISM described in Figure 2 were further redesigned by Sushil (2017). In m-TISM, successive pair-wise comparisons and transitivity check can be done simultaneously. It involves combining the first five steps of traditional TISM (I, II, III, IV, V) into a single phase (Figures 3, 4 and 5). Therefore, m-TISM helps in reducing the number of iterations altogether and providing a completely transitive reachability matrix.

Figure 3 Modified TISM showing paired comparisons and transitivity checks together (at organisational level) (see online version for colours)



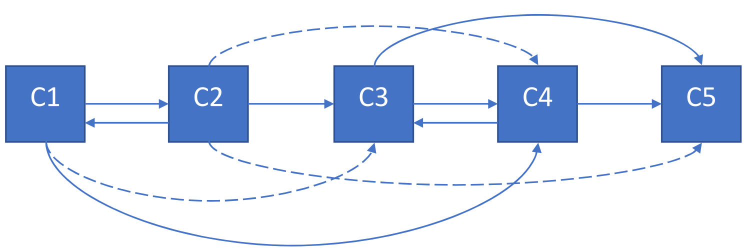
Notes: C1 = Firm size; C2 = Firm age; C3 = Firm leadership; C4 = Knowledge acquisition; C5 = Research and development.

Figure 4 Modified TISM showing paired comparisons and transitivity checks together (at industry level) (see online version for colours)



Notes: C1 = Organisational encouragement; C2 = Quality of human resources; C3 = Environmental uncertainty; C4 = Governmental support.

Figure 5 Modified TISM showing paired comparisons and transitivity checks together (at country level) (see online version for colours)



Notes: C1 = Institutions; C2 = Infrastructure; C3 = Human capital and research; C4 = Market sophistication; C5 = Business sophistication.

3.2.1 Step VI: level-wise partition on reachability matrix

Level-wise partition is conducted to determine the status of the factors at each level. The antecedent and reachability sets are determined for all elements, and the levels are defined based on the intersection. The reachability set comprises the elements within the same level that the element can or may affect. The antecedent set consists of elements that affect it from lower levels and elements with a strong connect affect it from the top level. The factors at the above level cannot reach the factors below their level. This means the elements in the top level are affected by the sub-level factors. An intersection of the antecedent set and the reachability set will subsume the reachability set if the element is at the higher level. The upper-level elements are removed for further iterations, and this is continued until all the levels are determined.

Each innovation level is partitioned into two to three levels, as depicted in Tables 9–14.

Table 9 Partitioning matrix innovation (organisational level, positioned at level I)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C1	1, 3, 4, 5	1, 2, 3	1, 3	
C2	1, 2, 3, 4, 5	2	2	
C3	1, 3, 4, 5	1, 2, 3	1, 2, 3	
C4	4, 5	1, 2, 3, 4, 5	4, 5	I
C5	4, 5	1, 2, 3, 4, 5	4, 5	I

Table 10 Partitioning matrix innovation (organisational level, positioned at level II, III)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C1	1, 3	1, 2, 3	1, 3	II
C2	1, 2, 3	2	2	III
C3	1, 3	1, 2, 3	1, 3	II

Table 11 Partitioning matrix innovation (industry level, positioned at level I)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C1	1, 2	1, 2, 3, 4	1, 2	I
C2	1, 2	1, 2, 3, 4	1, 2	I
C3	1, 2, 3, 4	3, 4	3, 4	
C4	1, 2, 3, 4	3, 4	3, 4	

Table 12 Partitioning matrix innovation (industry level, positioned at level II)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C3	3, 4	3, 4	3, 4	II
C4	3, 4	3, 4	3, 4	II

Table 13 Partitioning matrix innovation (country level, positioned at level I)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C1	1, 2, 3, 4, 5	1, 2	1, 2	
C2	1, 2, 3, 4, 5	1, 2	1, 2	
C3	3, 4, 5	1, 2, 3, 4	3, 4	
C4	3, 4, 5	1, 2, 3, 4	3, 4	
C5	5	1, 2, 3, 4, 5	5	I

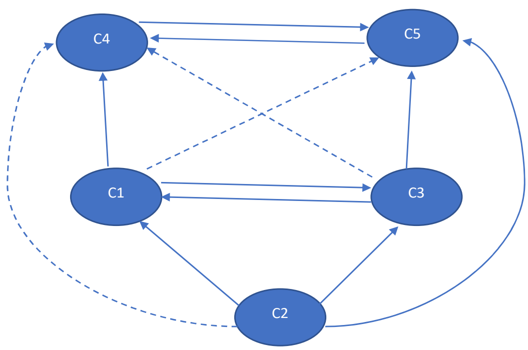
Table 14 Partitioning matrix innovation (country level, positioned at level II, III)

Variables	*Reachability set*	*Antecedent set*	*Intersection set*	*Level*
C1	1, 2, 3, 4	1, 2	1, 2	III
C2	1, 2, 3, 4	1, 2	1, 2	III
C3	3, 4	2, 3, 4	3, 4	II
C4	3, 4	2, 3, 4	3, 4	II

3.2.2 Step VII: diagraph development

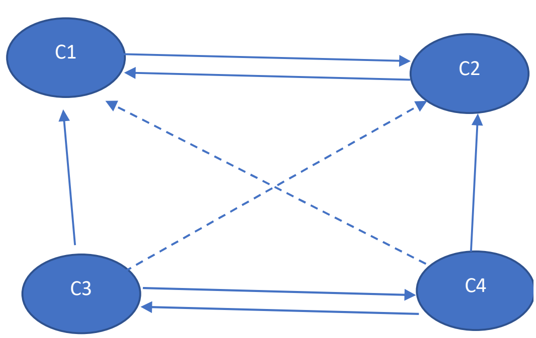
A graphical representation of the levels with direct links is to be developed. The diagraph is to be designed, where the various levels and links are drawn to display the relationship between each of the factors. The transitive relationships are gradually examined and represented by a segregated line. The digraphs for each of the levels, organisational, industry and country, are presented in Figures 6, 7 and 8, respectively.

Figure 6 Digraph showing direct and transitive links (organisational level) (see online version for colours)



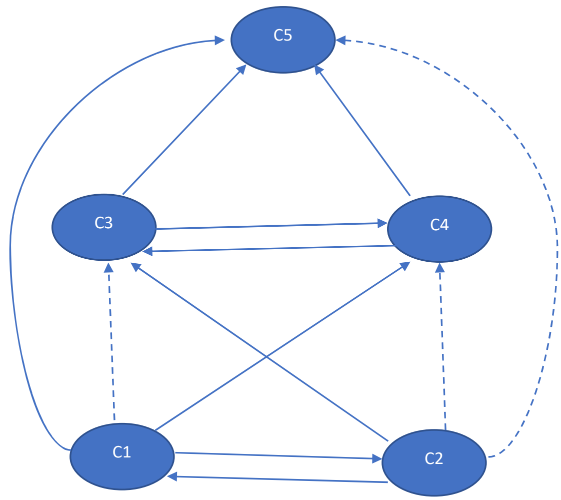
Notes: C1 = Organisational encouragement; C2 = Quality of human resources; C3 = Environmental uncertainty; C4 = Governmental support.

Figure 7 Digraph showing direct and transitive links (industry level) (see online version for colours)



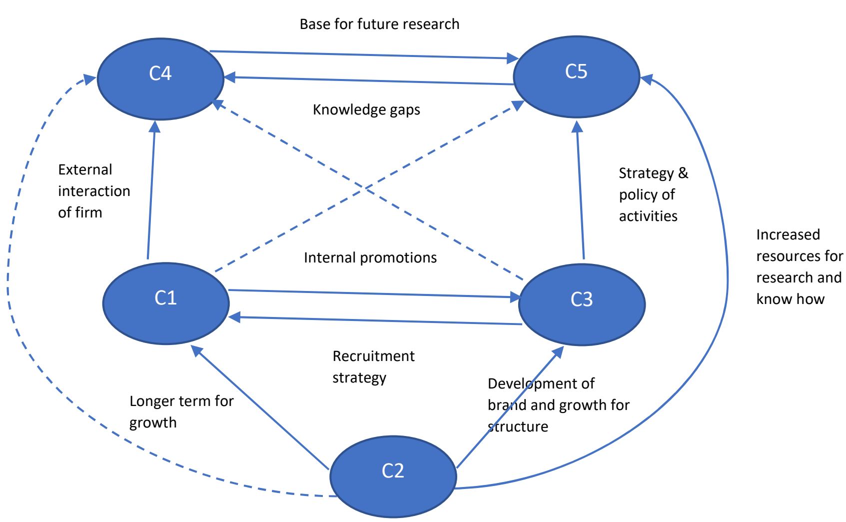
Notes: C1 = Firm size; C2 = Firm age; C3 = Firm leadership; C4 = Knowledge acquisition; C5 = Research and development.

Figure 8 Digraph showing direct and transitive links (country level) (see online version for colours)



Notes: C1 = Institutions; C2 = Infrastructure; C3 = Human capital and research; C4 = Market sophistication; C5 = Business sophistication.

Figure 9 TISM diagram with interpretation (organisational level) (see online version for colours)



Notes: C1 = Firm size; C2 = Firm age; C3 = Firm leadership; C4 = Knowledge acquisition; C5 = Research and development.

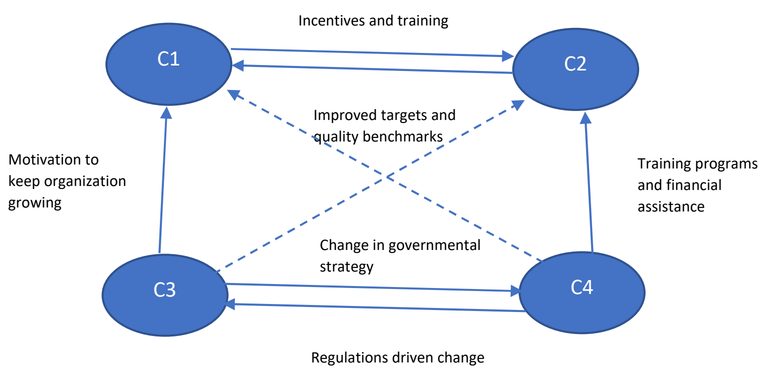
3.2.3 Step VIII: development of binary interpretive matrix from the diagraph

The interaction matrix is developed from the interpretive matrix, and the interpretations are selected from the created knowledge base. The interaction matrix is in a binary format, which is interpreted using the relevant interpretation to convert it into an interpretive matrix. Interpretations for transitive relations are considered only if they are significant (provided in appendix).

3.2.4 Step IX: total interpretative structural model development

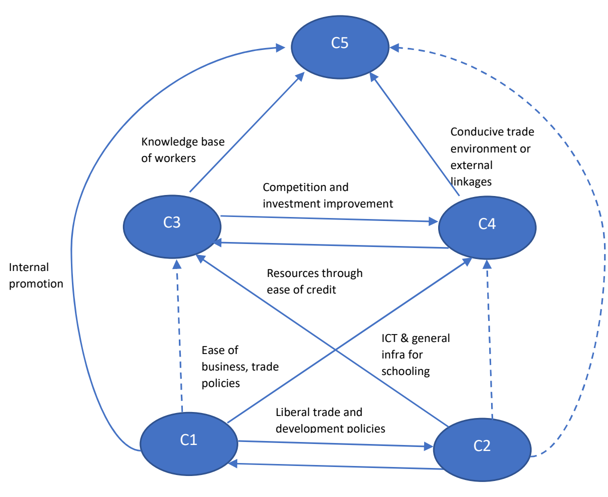
The relationships and interpretive information from the interaction matrix are utilised to derive TISM. The nodes of the diagraph are replaced and now depicted by the interpretation of each of these factors. At this level, the transitive links are removed to reduce the complexity. The conversion of the links and the nodes in the model provide the final m-TISM diagram. The final TISM diagrams at the organisational, industry and country levels are shown in Figures 9, 10 and 11, respectively.

Figure 10 TISM diagram with interpretation (industry level) (see online version for colours)



Notes: C1 = Organisational encouragement; C2 = Quality of human resources; C3 = Environmental uncertainty; C4 = Governmental support.

Figure 11 TISM diagram with interpretation (country level) (see online version for colours)



Notes: C1 = Institutions; C2 = Infrastructure; C3 = Human capital and research; C4 = Market sophistication; C5 = Business sophistication.

4 MICMAC analysis

MICMAC analysis was conducted to explore and outline the factors of innovation at the organisational, industry and country levels on the basis of their dependence and driving power (Tables 15, 16 and 17, respectively). Factors at each level (organisational, industry and country) were classified into four separate quadrants, namely autonomous, dependent, linkage and independent (Figures 12, 13 and 14, respectively).

Table 15 Driving and dependence power (organisational level)

	C1	*C2*	*C3*	*C4*	*C5*	*Driving power*
C1	1	0	1	1	1*	4
C2	1	1	1	1*	1	5
C3	1	0	1	1*	1	4
C4	0	0	0	1	1	2
C5	0	0	0	1	1	2
Dependence power	3	1	3	5	5	

Table 16 Driving and dependence power (industry level)

	C1	*C2*	*C3*	*C4*	*Driving power*
C1	1	1	0	0	2
C2	1	1	0	0	2
C3	1	1*	1	1	4
C4	1*	1	1	1	4
Dependence power	4	4	2	2	

Table 17 Driving and dependence power (country level)

	C1	*C2*	*C3*	*C4*	*C5*	*Driving power*
C1	1	1	1*	1	1	5
C2	1	1	1	1*	1*	5
C3	0	0	1	1	1	3
C4	0	0	1	1	1	3
C5	0	0	0	0	1	1
Dependence power	2	2	4	4	5	

Figure 12 MICMAC analysis of the factors at organisational level

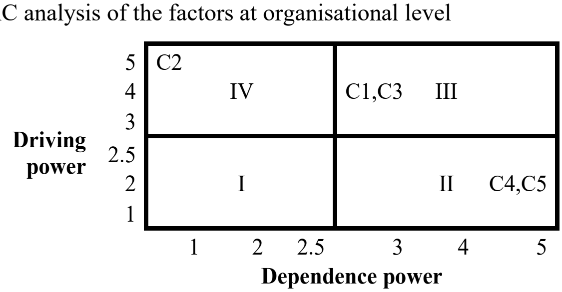


Figure 13 MICMAC analysis of the factors at industry level

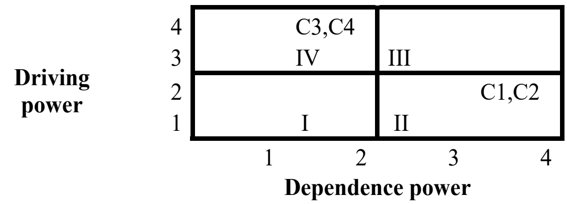
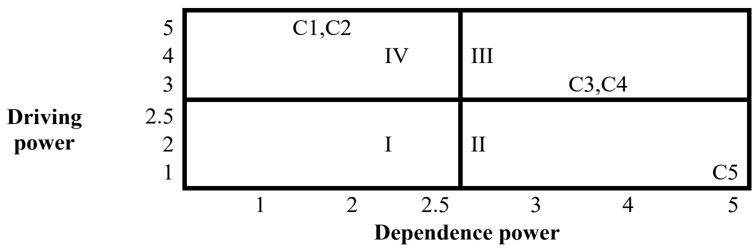


Figure 14 MICMAC analysis of the factors at country level



4.1 Quadrant 1 (Autonomous)

Factors in this group have weak driving and weak dependence power in the first quadrant and are relatively disconnected from the system. At the organisational, industry and country levels, no factor was present in the autonomous group, which means that all the identified factors have a significant effect on innovation and are important for study.

4.2 Quadrant 2 (Dependent)

These factors have strong dependence power but weak driving power. They are placed in the second quadrant and do not affect other factors.

At the organisational level, the following two factors are present in the second quadrant (Figure 9):

1 Knowledge acquisition (C4) had high dependence power (05) and is placed at the topmost level of the TISM hierarchy.

2 Research and development (C5) had weak driving power (02) and high dependence power (05).

At the industry level, the following two factors are present in the second quadrant (Figure 10):

1 Organisational encouragement (C1) had high dependence power (04) and weak driving power (02).

2 Quality of human resources (C2) had high dependence power (04) and occupies the topmost level of hierarchy.

At the country level (Figure 11), only one factor, named business sophistications (C5), is present in the second quadrant with high dependence power (05) and low driving power (01). It occupies the topmost level of hierarchy.

4.3 Quadrant 3 (Linkage)

Factors in this quadrant possess strong dependency and strong driving power. As the name suggests, factors in this quadrant are highly linked, volatile and unstable, which means that any action on these factors will significantly affect other factors.

At the organisational level, the following two factors were identified in this quadrant:

1 Firm size (C1) with high dependence (03) and high driving power (04).

2 Firm leadership (C3) having high dependence (03) and high driving power (04).

Both these factors appeared at the middle level of the TISM model.

At the industry level, no factor is present in the third quadrant.

At the country level, the following two factors were identified in the third quadrant:

1 Human capital and research (C3) with high dependence (04) and high driving power (03)

2 Market sophistication (C4) having high dependence (04) and high driving power (03), with both occupying the middle level in the TISM hierarchy.

4.4 Quadrant 4 (Independent)

Factors in this quadrant have strong driving power but weak dependence power.

At the organisational level, only one factor named firm age (C2) was identified in the fourth quadrant having strong driving power (05) and weak dependence power (01). It occupies the base of the TISM hierarchy.

At the industry level, the following two factors were identified in the fourth quadrant:

1 Environmental uncertainty (C3) with high driving power (04) and low dependence power (02)

2 Governmental supports (C4) with high driving power (04) and low dependence power (02)

At the country level, the following two factors were identified in the fourth quadrant:

1 Institutions (C1) with high driving power (05) and low dependence power (02)

2 Infrastructure (C2) with high driving power (05) and low dependence power (02)

All the factors in the fourth quadrant occupy the bottom level of the TISM model and need to be handled carefully as they can influence other factors.

5 Results and discussion

Figure 9 represents the hierarchical model of the factors that affect innovation at the firm level. Based on the outcome of the modified TISM model, it is found that at the firm level, firm age is the base factor affecting innovation and occupying level 3. The firm develops and grows over time and so do the resources at hand, including the financial, strategic and brand gains. The role firm age plays are evident from its impact on the quality of research, the leadership at the helm and the growth of the company. Younger firms tend to have more agility and risk-taking capabilities, leading to a finer connect with innovation, while older firms have extensive resources and expertise. Firm age directly affects the firm size and firm leadership, which form the next level (level 2). Firm size can focus on the financial or human capital size, both of which impact the quality of innovation and agility of the innovation in the firm. Firm size increases along with the age of the organisation, providing the necessary resources for growth and innovation. Firm leadership and ownership provide the necessary guidance and strategy to the firm; therefore, they carve the path for research and growth. A visionary leader can help change the face of the firm and deeply affect the inclination of the organisation towards innovation. The leadership moulds the strategy of the firm, affecting the other factors. The topmost level consists of the knowledge acquisition and research and development activities (level 1). More access to funds and human resources can help better knowledge acquisition and research in the firm. Research and knowledge acquisition are the eventual factors in firm-level innovation. The quality of research and the extent of knowledge acquisition can change the face of the innovation drive of a firm. Knowledge can be acquired from external sources in the form of researchers, or the organisation can considerably reduce the efforts and time for innovation, which forms the basis for further research. Research conducted by the firm can help find new avenues for innovation.

At the industry level, a more comprehensive view is to be taken. Through the TISM model (Figure 10), it is found that environmental uncertainty and governmental support from the base of the factors affect innovation (level 2). Environmental uncertainty in the form of lack of knowledge about the internal and external environment of the companies can increase chances of growth fluctuations. The lack of information influences innovation due to the limitation of the risk-absorbing capacity of the industry. Governmental support can make or break an industry, and the right policy intervention at the right time can enable financial and research support necessary to boost innovation in the industry. In addition, governments can sway international investments in the form of knowledge and funds from one industry to another; therefore, they play a major part in the innovation levels in an industry. The focus on the micro, small and medium enterprises (MSME) sector is evident from the governmental support being provided to this sector in India. A major section of analysis from the government's end is focused on MSMEs, leading to a more aware sector; as a result, the growth and innovation in this sector is becoming evident. The quality of human resources and organisational encouragement to the internal factors form the next level (level 1). Organisational encouragement provides the necessary motivation to move past the hurdles in the path of innovation. The encouragement of risk-taking and idea generation sparks the creative edge of an industry, helping in the growth of innovation. The quality of human resources affects the focus on creativity and idea generation. The minds of the workforce are essential for innovation in the industry.

Figure 11 represents the hierarchical model of the factors that impact innovation at the country level. In the context of innovation at the country level, the global innovation index has been quantifying innovation being conducted and the national capacity for innovation globally. Institutes and the infrastructure form the basis of the macro level, i.e., they occupy level 3 of the hierarchy. Sound governmental structure, political stability and business ease provide a base for creativity and potential in citizens. The access to necessary resources decreases the hurdles and paves the path for eased innovation. Market sophistication, human capital and research form the next layer, i.e., level 2. The awareness levels of the market, competitiveness, credit access and maturity help gain information about the environment and prepare a better strategy for growth and innovation. Market sophistication provides the external view for a sculpted approach and better risk mitigation. Human capital and research go hand in hand with market sophistication. Human capital and research aim for a qualitative approach to innovation, where the human resource efficiency and research conducted by the citizens pave the way for exponential innovation. The education provided to the citizens and research infrastructure can provide the citizens with the right tools to make their nation a harbour for innovation. Business sophistication forms the highest level (level 1), directly influencing the innovation at the country level. Business sophistication encompasses efficiency and productivity, leading to focused usage of resources and energy for future growth. The conduciveness of firms to assist innovation increases with enhanced business sophistication by increase in the linkage of industry with academics and knowledge absorption.

6 Conclusions

The area of management abounds with extensive discoveries by experts and a variety of models. TISM has been proven to capture the insights and thoughts of experts (Kumar, 2013). ISM interprets the relationship of factors linked to contextual relationships between the paired combinations of elements, while the TISM elements use an interpretation matrix to capture the inputs of experts. In this paper, we have attempted to focus on the three questions described by Whetten (1989) and Sushil (2012): what, how and why. The factors that affect innovation, answering the question 'what', were identified at the firm, industry and country levels through literature review and inputs from academicians. The factors were narrowed down based on their logical connection and importance as per previous research. How and why the factors affect each other, and innovation have been conceptualised and studied by the usage of m-TISM, which was based on inputs from industrialists and academicians collected through questionnaires and interviews. Using the MICMAC analysis, the autonomous, dependent, linkage and independent nature of factors were studied for all three levels.

At the firm level, knowledge acquisition and research and development are dependent antecedents. Firm size and firm leadership act as linkage factors for innovation and are links between driving and dependent factors. The driving factor for innovation is firm age, which acts as an independent factor; therefore, it plays an important role in innovation at the organisational level. At the industry level, the quality of human resources and organisational encouragement are dependent factors, whereas environmental uncertainty and government support are driving factors; these play a significant role in innovation. Business sophistication is a dependent factor at the country level, whereas market sophistication and human capital and research are linkage factors that provide a link between driving and dependent factors. Institutions and infrastructure are independent factors that need to be handled carefully as they can influence other factors.

6.1 Limitations of the study

As a part of the research, the factors have been taken into consideration based on the earlier surveys and research conducted by scholars. The research and surveys have been centric to certain sectors or samples, as in the case of the national innovation survey, which has been based on the ASI 2009–2010 data for a sample of 208,415. The focus of the survey is on the manufacturing sector, while in the other papers, the focus is on services and is nation specific. TISM has been used in this research to understand the complex dynamics between the multiple factors affecting innovation. The expert opinions taken into consideration for the development of TISM have been numbered in this research and are limited by the bias of the experts. A questionnaire can be provided to multiple experts to make the model more efficient by seeking to the point responses. Certain studies have divided the innovation aspects into product and process innovation throughout the research, while the focus is on innovation in general and is not centric to the process or product. In addition, the model developed in this research has not yet been validated. Therefore, in future studies, validation can be done using statistical techniques, such as structural equation modelling or using the LISREL software.

6.2 Future research directions

Our research examines the complex interconnection between the multiple factors affecting innovation and their influence on innovation. Attention should be paid to the type of impact the factors have. Furthermore, the deep research on each of the factors and their outcome, based on changes to the factors, should be delved into further. After the articulation of the model, each of these factors could be quantified to check the practical feasibility of the model. The theoretical structure focuses on the qualitative aspect of innovation. In the case of firm-level innovation, the sample size of firms can be taken into consideration to understand the practical implications of the model structured in this research. In addition, to increase the depth of the research, further elements from various sectors can be considered. Globally, the quantification of intra- and inter-nation innovation is evident through the implementation of various innovation indices. Quantification combined with a qualitative approach can provide deeper insights into the key to innovation. A deeper focus into the relationship between the factors and innovation can provide nations with the opportunity to be more economically competitive and provide enhanced living conditions to their citizens. Our research suggests broad avenues for the improvement of innovation in India and aspects that can be focused on to boost the start-up drive. The Start-up India mission is on the rise, owing to the governmental support. This initiative can be promoted with a focal point based on the research conducted. This can be further advanced by analysis and research on factors specific to a product or process innovation specific to a firm or sector. In the case of the Indian start-up mission, the focus is on certain industries, and mainly, on the MSME sector. Therefore, to understand the specificities, these sections should be researched from all directions.

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Appendix

Table A1 Interpretive matrix (organisational level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	-	-	Provides compensation perks	Increased funds for easy access	-
C2	Provides time for establishment and defines risk capabilities	-	Brand connect for established leadership	-	-
C3	Modifies strategy adhered to by the firm	-	-	-	Leadership strategy can mould the direction of research
C4	-	-	-	-	Adds a base to the research and reduces overlaps
C5	-	-	-	Fills the gaps in knowledge acquired	-

Table A2 Interpretive matrix (industry level)

	C1	*C2*	*C3*	*C4*
C1	-	Enhances the benchmark for quality	-	-
C2	Improves visibility and competitiveness	-	-	-
C3	Adverse conditions can reduce organisational encouragement	-	-	Uncertainty waivers the government strategy
C4	-	Training programs	Policy changes and funding can cushion uncertainty	

Table A3 Interpretive matrix (country level)

	C1	*C2*	*C3*	*C4*	*C5*
C1	-	Policy structure and liberation provided	-	Regulations will moderate trade and credit formats	Business policy assisted linkages and knowledge absorption
C2	Provision of ICT and general infrastructure	-	Ecological stability increases avenues for research		
C3		-	-	Competition and investments built on base of quality human resources	Knowledge base of workers improves
C4			Resources for future research and education	-	Credit/ investment in market improves knowledge of production
C5	-		-		

Table A4 Interpretive logic knowledge base at organisational level

Sl. no.	*Elements*	*Paired comparison of change forces*	*Y/N*	*In what way a change force will influence/ enhance other change force?*
1	C1-C2	Firm size will influence or enhance firm age	N	
2	C2-C1	Firm age will influence or enhance firm size	Y	Longer time span for increase in human capital
3	C1-C3	Firm size will influence or enhance firm leadership	Y	Prompts attractive opportunities
4	C3-C1	Firm leadership will influence or enhance firm size	Y	Right strategy for exponential growth

Table A4 Interpretive logic knowledge base at organisational level (continued)

Sl. no.	*Elements*	*Paired comparison of change forces*	*Y/N*	*In what way a change force will influence/ enhance other change force?*
5	C1-C4	Firm size will influence or enhance knowledge acquisition	Y	Improved resources for easy access
6	C4-C1	Knowledge acquisition will influence or enhance firm size	N	
7	C1-C5	Firm size will influence or enhance research and development	N	
8	C5-C1	Research and development will influence or enhance firm size	N	
9	C2-C3	Firm age will influence or enhance firm leadership	Y	Brand provides the necessary perks to leadership
10	C3-C2	Firm leadership will influence or enhance firm age	N	
11	C2-C4	Firm Age will influence or enhance Knowledge Acquisition	N	
12	C4-C2	Knowledge Acquisition will influence or enhance Firm Age	N	
13	C2-C5	Firm Age will influence or enhance Research Development	Y	Level of resources assists in research
14	C5-C2	Research and Development will influence or enhance Firm Age	N	
15	C3-C4	Firm Leadership will influence or enhance Knowledge Acquisition	N	
16	C4-C3	Knowledge Acquisition will influence or enhance Firm Leadership	N	
17	C3-C5	Firm Leadership will influence or enhance Research and Development	Y	Leadership insight can improve internal strategy
18	C5-C3	Research and Development will influence or enhance Firm Leadership	N	
19	C4-C5	Knowledge Acquisition will influence or enhance Research and Development	Y	knowledge base adds and reduces overlap in research
20	C5-C4	Research and Development will influence or enhance Knowledge Acquisition	Y	Research fills gaps in knowledge base of organisation

Table B1 Interpretive logic knowledge base at industry/sector level

Sr no.	*Elements*	*Paired comparison of change forces*	*Y/N*	*In what way a change force will influence/ Enhance other change force?*
1	C1-C2	Organisational encouragement will influence or enhance quality of human resource	Y	Organisational encouragement adds to the benchmark of human resources
2	C2-C1	Quality of human resource will influence or enhance organisational encouragement	Y	Improved quality enhances organisations visibility
3	C1-C3	Organisational encouragement will influence or enhance environmental uncertainty	N	
4	C3-C1	Environmental uncertainty will influence or enhance organisational encouragement	Y	Adverse conditions can reduce organisational encouragement
5	C1-C4	Organisational encouragement will influence or enhance governmental support	N	
6	C4-C1	Governmental support will influence or enhance organisational encouragement	Y	Policy changes can improve organisational encouragement
9	C2-C3	Quality of human resource will influence or enhance environmental uncertainty	N	
10	C3-C2	Environmental uncertainty will influence or enhance quality of human resource	Y	Adverse conditions can cause drop in quality by loss of human resources
11	C2-C4	Quality of Human resource will influence or enhance governmental support	N	
12	C4-C2	Governmental support will influence or enhance quality of human support	Y	Training programs
15	C3-C4	Environmental uncertainty will influence or enhance governmental support	Y	Environmental uncertainty can change government strategy
16	C4-C3	Governmental support will influence or enhance environmental uncertainty	Y	Policy changes impact the environment

Table C1 Interpretive logic knowledge base at country level

Sl. no.	*Elements*	*Paired comparison of change forces*	*Y/N*	*In what way a change force will influence/ Enhance other change force?*
1	C1-C2	Institutions will influence or enhance Infrastructure	Y	Policy structure and liberation provided
2	C2-C1	Infrastructure will influence or institutions	Y	Provision of ICT and general infrastructure

Table C1 Interpretive logic knowledge base at country level (continued)

Sl. no.	*Elements*	*Paired comparison of change forces*	*Y/N*	*In what way a change force will influence/ Enhance other change force?*
3	C1-C3	Institutions will influence or enhance Human capital and research	N	
4	C3-C1	Human capital and research will influence or enhance institutions	N	
5	C1-C4	institutions will influence or enhance market sophistication	Y	Regulations will moderate trade and credit formats
6	C4-C1	Market Sophistication will influence or enhance institutions	N	
7	C1-C5	Institutions will influence or enhance business sophistication	Y	Business policy assisted linkages and knowledge absorption
8	C5-C1	Business sophistication will influence or enhance institutions	N	
9	C2-C3	Infrastructure will influence or enhance human capital and research	Y	Ecological stability increases avenues for research
10	C3-C2	Human capital and research will influence or enhance infrastructure	N	
11	C2-C4	Infrastructure will influence or enhance market sophistication	N	
12	C4-C2	Market sophistication will influence or enhance infrastructure	N	
13	C2-C5	Infrastructure will influence or enhance business sophistication	N	
14	C5-C2	Business sophistication will influence or enhance infrastructure	N	
15	C3-C4	Human capital and research will influence or enhance market sophistication	Y	Competition and investments built on base of quality human resources
16	C4-C3	Market sophistication will influence or enhance human capital and research	Y	Resources for future research and education
17	C3-C5	Human capital and research will influence or enhance business sophistication	Y	Knowledge base of workers improves
18	C5-C3	Business sophistication will influence or enhance human capital and research	N	
19	C4-C5	Market sophistication will influence or enhance business sophistication	Y	Credit/ investment in market improves knowledge of production
20	C5-C4	Business Sophistication will influence or enhance market sophistication	N	