

# Flexible System Approach for Understanding Requisites of Product Innovation Management

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**Abstract** Innovation may be a key towards business success and winning over competition prevailing in the market. Effective management of innovations may be recognized as a requirement to sustain the existing position of an organization and also to attract new customers for gaining a competitive advantage over other players in the market. Product innovativeness, regarding ‘new’/‘significantly improved’: features; functions, aesthetics etc., may be valued as an increasingly important research area in Indian context for domestic and international business sustainability. It has been attempted to identify and understand important requisites for product innovation management in Indian organizations. Literature review approach has been used for identifying requisites and benefits of product innovation management. AHP methodology has been used to understand the importance of requisites of product innovation management. ‘Total interpretive structural modelling’ has been utilized to develop and appropriately construe interpretive structural model of requisites and benefits of product innovation management. This paper may

also help to practicing innovation managers of various Indian organizations to identify, understand and analyse ‘strengths and weaknesses’ of their organization in managing resources and activities involved in ‘product innovation management processes’.

**Keywords** Analytic hierarchy process (AHP) · Innovation management · Literature review · Product innovativeness · Requisites for product innovation management · Total interpretive structural modelling (TISM)

## Introduction

Due to globalization and rapid changes in business environment, organizations have been facing pressures to provide better products/services for enhanced customer satisfaction; higher profits; and gaining competitive advantage (Singh and Sushil 2004). Innovation incorporation in goods and services may be one of the best solutions for winning the challenge towards improving business processes/activities; and enhancing values of the goods and services (Aarikka-Stenroos and Jaakkola 2012; Martensen and Mouritsen 2014). Most organizations operating in globalized business scenarios have been paying increasing attention to innovation as a key success factor towards competitiveness (Dervitsiotis 2010; Evanschitzky et al. 2012). In fact, innovation has been identified as one among most elusive facet of organizational processes and outcomes which need to be quantitatively and qualitatively analysed (Carayannis and Provan 2008). Innovating efforts may involve combining various types of resources, capabilities, knowledge and skills in the search for a competitive advantage, either through the development of

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new products with enhanced features or changes to existing ones targeting reduction in production costs (Fagerberg et al. 2006).

Innovation, with the creation of newer ideas and knowledge to help and enhance business performance regarding increased profits and cost-effectiveness, aims at improving upon business activities, practices and structures towards delivering customer-driven competitive products and services encompassing both radical and incremental innovations (Du Plessis 2007). Moreover, it may be referred to as a multi-stage process to transform concepts, perceptions and ideas into newer/improved: products; services; or activities/processes, towards advancing, competing and differentiating considerably and successfully in targetted markets (Baregheh et al. 2009). Recent business environment increasingly imposes need for innovation as a critical success factor of growth (including economic growth) and competitiveness of an individual company and whole industry as well (Aralica et al. 2008), and product innovation has been observed as an increasingly critical and emerging research area in Indian perspective for business sustainability (Mannan et al. 2016). In last few years, organizations from ‘less developed countries’ had been operating in relatively ‘protected business environment’; however, they must now be well prepared to face challenges of open ‘global competition’ by becoming fast and smart in adaptation (Hadjimanolis 1999). An apparent gap exists in understanding necessary requisites of product innovation management (PIM) in the Indian context.

### Objectives of the Paper

In this article, it has been emphasized to explore the area of ‘Product Innovation Management’. Innovation may be highly helpful in achieving a competitive advantage as well as business sustainability in rapidly developing countries like India; and therefore, it has been attempted to spot, understand and analyse necessary requisites for product innovation management in Indian industries. The objectives of the paper are to:

1. To identify relevant variables (requisites and benefits) of product innovation management in Indian industries;
2. To prioritize requisites and advantages of product innovation management, which will help practitioners towards directing efforts to manage product innovation implementation effective and fruitful; and
3. To develop a total interpretive structural model of important variables of product innovation management in Indian industries, which will help practitioners to understand hierarchical structural model in a fully interpretive way to manage product innovation implementation.

### Methodology

Literature review approach has been adopted for identifying significant variables (requisites and benefits) of product innovation management. Review of literature is a valid activity of research towards identifying and exploring the available content related to the research area and giving direction useful for the development of theory. It uses flexible systems approach (Sushil 1994) by combined use of AHP and TISM. In the present study, it is suggested to use an analytic hierarchy process (AHP) approach for prioritizing requisites and benefits of product innovation management. AHP, as a multi-attribute flexible decision support tool, had been developed by Saaty (1977). AHP technique utilizes multilevel structure of tasks, attributes, and sub attributes, in pair-wise mode (Saaty 1980, 2008; Luthra et al. 2013; Madaan and Mangla 2015) towards comparing and ranking alternatives for assisting decision-making (Saaty 2008; Kumar et al. 2009; Luthra et al. 2015). TISM may be useful in developing a knowledge base of the interpretive logic of interactions towards interpreting structural model completely (Sushil 2009; Nasim 2011; Wasuja and Sagar 2012; Yadav and Sushil 2014; Mangla et al. 2014; Patri and Suresh 2017).

Product innovation and its present status in India have been discussed in section “[Product Innovation](#)”. Necessary requisites and benefits of product innovation management have been identified in section “[Requisites and Benefits of Product Innovation Management](#)”. AHP and TISM-based models of requisites and benefits of product innovation management has been presented for better understanding of requisites and advantages of product innovation management in sections “[Analytic Hierarchy Process \(AHP\)-Based Ranking of Requisites and Benefits of Product Innovation Management](#)” and “[TISM-Based Modelling of Requisites and Benefits of Product Innovation Management](#)”. Discussions and concluding remarks have been given in last two sections providing limitations and future research directions.

### Product Innovation

Product innovativeness has often been explained as apparent originality, novelty, improvements or individuality of the goods/services or development of new products/services (Wang and Ahmed 2004). Product innovation is introduction of tangible or intangible goods and/or services which are significantly better with respect to their properties, functions, aesthetics and usage (Evangelista 2000); and it has to be a continuous, consistent and cross-functional effort involving increasing number of diverse competencies to transform business opportunities into products,

processes and services (Cormican and O’Sullivan 2004). Product innovation may be: new or wholly changed product; modestly improved product; new or superior accessory of an existing product; product differentiation etc.(Steward et al. 2008). A good product innovation management may provide various benefits to organizations such as: improving market position; improving brand name; fighting competition; attracting new customers; and sustaining existing customers (Chandy and Tellis 2000; Mu et al. 2009; Lin et al. 2013).

### Innovation Status in India

The thrust areas for raising competitiveness and profitability of micro, small and medium enterprises may include technology capabilities; procurement; and human resource management practices involving the development of skills; and finance and supply chain management. Innovation may be observed in various forms from ‘operational excellence and optimizations’ to ‘products/services originality’ (Mannan et al. 2015). Innovation ecosystem of India has been acquiring increasing granularity, and Indian innovation scenario has been becoming more local (regarding end-use conditions) noticeable by the availability of wide range of products and services (<http://www.ficci.com>).

Most innovation researchers have been focusing on developed countries in their research (McMahon and Thorsteinsdóttir 2013). China and India have now been recognized as countries that not only produce economic products but also develop and implement successful innovation practices in the global market (<http://www.scidev.net>). As reported by UNIDO, India has been among countries performing best in various manufacturing sectors in global scenario such as basic metals, textiles, pharmaceuticals, chemical, general machinery and equipment including electrical machinery; and this dominance is expected to be continued, and further increase in production may be observed because of many valid reasons that are advantages from supply-side, political stabilities and policy reforms, and private sector efforts towards making India globally preferred manufacturing hub. In fact, from short-term and long-term perspectives, innovation may play a vital role in bringing success and sustainability (<http://www.ibef.org>).

Indian economy is observing growth rate of 6–8% per annum, whereas exports’ growth rate is being observed as 30% CAGR; and numbers of Indian organizations can manage successfully towards competing internationally against the dynamic competition. It may further have inferred that this growth has been made possible due to the availability of enabling environment; increasing productivity of capital and labour considerably and consistently; achieving high quality at economical costs; continuous

efforts of organizations towards business performance improvement; and policy decisions to attract foreign investments in diverse sectors. (<http://www.knowledgecommission.gov.in>).

### Requisites and Benefits of Product Innovation Management

Product innovation management (PIM) has been increasingly explored research area in management and scientific literature over past 15 years. Reason for this interest may be realization about product innovation as a key success factor towards survival.

Literature has been searched and reviewed using science direct and Google scholar search engines by providing various keywords like product innovation management, innovation in India, and requirement or requisites and benefits of product innovation management. These identified requisites and benefits of product innovation management are explained in following subsections.

#### Important Requisites of Product Innovation Management

Eight essential requisites for product innovation management in Indian organizations have been identified: availability of funds; training and development; research and development facilities; organization culture; collaborations; management involvement, human capital, and customer involvement. These necessary requisites are explained as follows:

##### *Availability of Funds*

The most critical input for the success of innovation projects is the availability of funds. Funds available to the organization and financial institutions’ attitude towards providing funds are the major requirement to innovate new products (Romano 1990). It is vital to consider both creations of newer ideas and the resources that a region can gather to support these ideas. In fact, financial metrics/indices measure money allocated to an innovative project, which may be shown as an absolute amount or a percentage of sales/annual budget (Manoochchri 2010).

##### *Training and Development Efforts*

The training of technical personnel is a prime requirement for enhancing R & D activities towards the discovery of new products and usage (Afuah 2002; Zhou and Wu 2010). Transformational leadership and change management have been recommended to be an area of training and



improvement in developing as well as developed countries (Gumusluoglu and Ilsev 2009).

#### *R&D Facilities Availability*

R&D facilities have been identified as an important requisite for innovations, specifically in the field of engineering, medicine and the natural sciences etc.; and R&D activities for radical innovations have been observed fully/partly funded, directed and implemented by public organizations (Edquist 2011). Innovation has often been linked to R&D towards new/improved products creation; and many researchers argued that amplified R&D activities may lead to newer products conceptualization and then creation of enabling organizations to achieve higher competitive advantages as well as to grab market shares (Armbruster et al. 2008).

#### *Organization Culture*

Organizations that are newer always go for a radical change to improve their presentation; hence, they tend to use tactical leadership to achieve both innovative direction and pioneering perspective (Elenkov et al. 2005; Boal and Schultz 2007; Sarros et al. 2008; Botswana 2013). A culture supporting innovation has been recognized a prerequisite for the organization to acknowledge the necessity to innovate (Husain et al. 2002; Van der Panne et al. 2003). Employee involvement is to improve motivation and commitment of employees. Leveraging the knowledge and initiatives of employees (making employees free and comfortable to suggest (individual and team perspective) and implement (team perspective) new ideas to realize innovations) is important to adopt innovation in the organization (Van de Vrande et al. 2009).

#### *Collaborating Efforts*

For innovations to be successful in organizations, ideas required to be incubated to allow for larger association among organizational members to make arrangements to avoid losses related to the premature release of services or products into the market (Botswana 2013). Firms choose to collaborate because of various reasons. One of the reasons may be a reduction in risks involved in innovation. Companies may be willing to attain capabilities and resources that are difficult to create internal and may be obtained efficiently in market (Chesbrough et al. 2006; Soosay et al. 2008).

#### *Management Involvement*

Top management support may be identified as one of the most significant stakeholders in encouraging novelty; and if the top administration does not encourage creativity among employees, there are rare chances that innovative ideas will be even shared for further discussions towards adoption. In fact, management support for implementing innovative ideas for developing new/improved products/services may be crucial towards 'innovative process performance' (Sund 2008). Management and leadership are crucial to ensuring firm-level innovativeness are successfully achieved (Peris-Ortiz and Hervás-Oliver 2014). Frambach and Schillewaert (2002) examined the various management strategies, policies, practices and actions that facilitate firm innovativeness (Frambach and Schillewaert 2002).

#### *Human Capital*

Human capital has been crucial for engaging in interactive learning which, in turn, is conducive to innovation (Chaminade and De Fuentes 2012). Qualified human capital is considered as a central requisite towards organization's 'absorptive capacity building' and hence, may be considered as determinant of ability of organization to identify, locate, sort, acquire, share and use useful data, information and knowledge (Cohen and Levinthal 1990; Chaminade and De Fuentes 2012). Innovation experts may be required throughout the innovation process from policy framing to implementation to avoid complete failure or chances of not reaching full potential (Orcutt and AlKadri 2009).

#### *Customer Involvement*

Innovation processes involving customers directly by conducting active market research to identify their needs, and understand and analyse their perceptions for developing products because of the obvious reason that customers play central role in drawing attention of firms to improve and innovate products/services significantly to address specific customer needs (Sund 2008; Van de Vrande et al. 2009). Conceptualizing, developing and delivering new significantly differentiated products/services may solve major customer problems and help to satisfy customers by offering products/services with value proposition (Cooper and Edgett 2008; Kumar et al. 2013a, b, 2014).

## Benefits of PIM

Three identified advantages of PIM (improved/new innovative products; goodwill and brand image; and higher profits) are explained as follows:

### *Improved/New Innovative Products*

Product innovativeness enhances product advantage by addressing ‘customers’ perceived value’ enhancement; and high level of innovativeness reduces customer familiarity (Calantone et al. 2006). Innovations in products are much suitable for organizations willing to enter into newer markets towards responding customer needs faster and more efficiently, enhancing quality and variety of product, and gaining market share (Fritsch and Meschede 2001; Vaona and Pianta 2008; Nieto and Santamaría 2010).

### *Goodwill and Brand Image*

Organizations must innovate to keep ahead of their competitors and to attain brand image (Lee et al. 2012). Organizations have been increasingly looking for obtaining leverage and goodwill by extending brands utilizing innovativeness (Xie 2012). Product modernization has been one among critical factors towards the success of various established brands. It had been established as new product design launched for profitable purposes aiming towards promoting eminence and features of products that stem from creative designs throughout manufacturing processes (Vazquez-Brust and Sarkis 2012).

### *Higher Profits*

The demonstrated capability of innovation may drive profitable growth in both mature and emerging markets (Davila et al. 2012). Firms enhance margins of profit as buyers are prepared for paying higher for newer products and earn monopoly rents until imitation of newer products is managed by competitors (Fritsch and Meschede 2001).

## Analytic Hierarchy Process (AHP)-Based Ranking of Requisites and Benefits of Product Innovation Management

AHP technique had been utilized to categorize requisites and benefits of product innovation management. This technique analyses alternatives towards solving given problem utilizing comparisons (in pair-wise mode).

## AHP Methodology

AHP has following steps (Saaty 1980, 2008; Kumar et al. 2009; Luthra et al. 2013; Kumar 2014):

1. Establish structure of decision variables hierarchy wise;
2. Establish pair-wise comparison to construct matrices;
3. Check for consistency of priority of variables for each matrix of order  $n$  by using Eqs. (1) and (2)

$$CI = (\lambda_{\max} - n)/(n - 1) \quad (1)$$

$$CR = CI/RI \quad (2)$$

where  $CI$  = Consistency Index;  $\lambda_{\max}$  = Maximum eigen-vector;  $CR$  = Consistency Ratio; and  $RI$  = Random Index which varies with size of matrix.

## Ranking of Requisites and Benefits of PIM

We conducted brainstorming sessions during a workshop where experts (three were from industry, and three were from academia) were called. Experts were consulted during the sessions to make pair-wise comparisons between identified requisites of PIM the nature of contextual relationships among requisites of product innovation management. Ranking of requisites of PIM has been shown in Table 1.

From the results shown in Table 1, ‘Availability of funds’ is the most important requisite for effective product innovation management followed by ‘Management involvement’; ‘Organization culture’; ‘Customer involvement’; ‘Human capital’; ‘Collaborating efforts’; ‘Training and development efforts’; and ‘R&D facilities availability’.

Similar steps have been taken for ranking of benefits of product innovation management and tabulated in Table 2.

From the results shown in Table 2, ‘Improved/new innovative products’ has been rated the most significant benefit of effective product innovation management followed by ‘Goodwill and brand image’ and ‘Higher profits’ jointly.

## TISM-Based Modelling of Requisites and Benefits of Product Innovation Management

The TISM (Sushil 2012, 2016) is ISM extension (Warfield 1974) which may be suitably utilized to establish the hierarchical structure of the set of variables. TISM technique has been utilized to establish the hierarchical relationship among variables (requisites and benefits) of

**Table 1** Ranking of requisites of PIM

S. no.	Requisites of PIM	Pair-wise comparisons								Relative weights	Priority (Rank)
		1	2	3	4	5	6	7	8		
1	Availability of funds	1	4	3	3	3	2	3	2	0.270655	1st
2	Training and development (T&D) efforts	0.25	1	1	1	1	0.33	1	1	0.0796823	7th
3	R&D facilities availability	0.33	1	1	1	0.5	0.33	1	1	0.0775054	8th
4	Organization culture	0.33	1	1	1	3	0.5	1	1	0.106169	3rd
5	Collaborating efforts	0.33	1	2	0.33	1	0.25	1	1	0.0811432	6th
6	Management involvement	0.5	3	3	2	4	1	2	2	0.206272	2nd
7	Human capital	0.33	1	1	1	1	0.5	1	1	0.0865612	5th
8	Customer involvement	0.5	1	1	1	1	0.5	1	1	0.0920114	4th

Maximum eigen value = 8.2765

CI = 0.0395059

CR = CI/RI = 0.0395059/1.41 = 0.0280184

**Table 2** Ranking of benefits of PIM

S. no.	Benefits of PIM	Pair-wise comparisons			Relative weights	Priority (rank)
		1	2	3		
1	Improved/new innovative products	1	2	2	0.5	1st
2	Goodwill and brand image	0.5	1	1	0.25	2nd
3	Higher profits	0.5	1	1	0.25	2nd

Maximum eigen value = 3.00

CI = 0

CR = CI/RI = 0/0.58 = 0

product innovation management. Opinions from experts from academia and industry have been required to recognize relationships (contextual) among each pair of variables with the appropriate logic behind all identified contextual relationships. Experts are supposed to establish the reason for ' $n*(n - 1)$ ' pairs of relationships for ' $n$ ' variables to develop TISM-based model.

The stepwise procedure of TISM has been presented and illustrated below; however, the central tool of ISM (Haleem et al. 2012; Luthra et al. 2011; Mangla et al. 2012, 2013; Kumar et al. 2013a; Sandeep et al. 2013), i.e. reachability matrix development and partitioning steps have been adopted as it is in TISM methodology.

### Step I Identify, sort and Define Variables

TISM modelling starts with the identification of variables whose contextual relationships are to be analysed and then, defining them appropriately. In the context of research, relevant variables (eight requisites and three benefits) of product innovation management in Indian organizations have been identified through extensive review of the literature. Further, these variables have been validated by experts' opinions.

### Step II Establish Contextual Relationship

Towards developing the model, it has been found critical to define contextual relationships among variables. Same experts' group consulted for obtaining AHP rating was conferred during the brainstorming session in the workshop to establish the direction of contextual relationships among variables (requisites and benefits) of product innovation management.

### Step III Analyse Direction of Relationships between Variables

Similar to traditional ISM methodology, the direction of each relationship between variables is analysed after identifying the existence of relationships.

### Step IV Interpretive Logic of Pair-wise Comparisons

In this step, interpretive matrix concept is used to interpret each paired comparison appropriately. Based on discussions with experts, Interpretive Logic–Knowledge Base for the contextual relationship of variables (only those having response Y (Yes)) has been presented in “Annexure

1: Interpretive Logic–Knowledge Base of Variables of PIM”.

**Step V** Reachability Matrix (RM) and Checking for Transitivity

Paired comparisons in Interpretive Logic–Knowledge Base have been transformed into RM by making entry ‘1’ in *i–j* cell, if a respective entry in the knowledge base is ‘Y’, otherwise entry will be ‘0’; final updated RM after checking for transitivity is shown in Table 3.

**Step VI** Level Partitioning

Similar to ISM methodology, level partitioning is done to analyse level-wise placement of variables and determine reachability set, antecedent set and intersection laid down for all decision variables. Finally, after all the iterations, the identified eleven variables of product innovation management have been partitioned into six levels as presented in Table 4.

**Step VII** Digraph Development

Variables have been arranged (in a graphical manner) as per their levels with all directed links as analysed during the process of reachability matrix development.

**Step VIII** Interaction Matrix

Digraph has been transformed further into binary interaction matrix showing all interactions by ‘1’ entry. An interaction matrix and interpretive matrix have been presented in Tables 5 and 6, respectively.

Lastly, *digraph has been translated into ISM* (for details see “[Annexure 2: ISM-based Model for Requisites and Benefits of Product Innovation](#)”) by interpreting the node in box-bullet representation is presented in Fig. 1.

**Step IX** TISM Model

**Table 4** Final levels for variables of PIM

Level	Variables names
1st	Higher profits Goodwill and brand image
2nd	Improved/new innovative products
3rd	Customer involvement
4th	R&D facilities Training and development Human resources Organization culture
5th	Collaborations Availability of funds
6th	Management involvement

**Table 5** Interaction matrix for variables of PIM (binary matrix)

Variables of product innovation management	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
V1		1	1		1		1				
V2			1				1	1			
V3			1							1	
V4							1				
V5	1		1								
V6	1				1						
V7		1		1				1			
V8										1	
V9											1
V10										1	1
V11											1

**Table 3** Reachability matrix for variables of PIM

Variable S.N.	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
V1	1	1	1	1	1	0	1	1	1	1	1
V2	0	1	1	1	0	0	1	1	1	1	1
V3	0	1	1	1	0	0	1	1	1	1	1
V4	0	1	1	1	0	0	1	1	1	1	1
V5	1	1	1	1	1	0	1	1	1	1	1
V6	1	1	1	1	1	1	1	1	1	1	1
V7	0	1	1	1	0	0	1	1	1	1	1
V8	0	0	0	0	0	0	0	1	1	1	1
V9	0	0	0	0	0	0	0	0	1	1	1
V10	0	0	0	0	0	0	0	0	0	1	1
V11	0	0	0	0	0	0	0	0	0	1	1



**Table 6** Interpretive matrix for variables of PIM

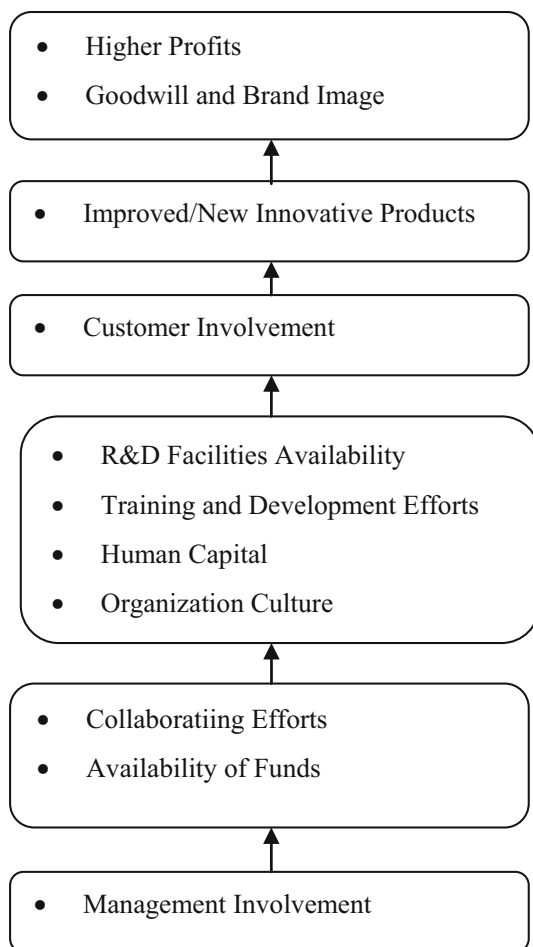
V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
V1	Fund allocation for T&D	Requisite for R&D facilities availability		Sound financial position of firm will attract collaborating partners	Qualified and skilled human resource may be hired for appropriately higher salaries					
V2		Appropriate training will help in identifying and installing appropriate R&D facilities			To develop and polish skills		Through awareness program			
V3	Required for appropriate training							Towards researching for innovations		
V4					Help in attracting and retaining better human resource					
V5	Financial collaborations may help to generate funds	Technical collaborations will provide access to R&D facilities and know-how								
V6	To make decisions about fund generation and allocation			To initiate and make policy decision						
V7	Skilled human resource to foster		Help in developing healthy culture				Through direct contact with 'sales and after sales personnel.'			



Table 6 continued

V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11
V8								Customer feedback will help in carrying out innovations in products		
V9									Innovations will improve brand image and goodwill	Premium may be charged for new/improved products
V10										Goodwill and better brand image will help in attracting new customers and retaining existing ones
V11									Sound market position will enhance goodwill and brand image	





**Fig. 1** Box-bullet representation ISM-based model for requisites and benefits of PIM

Nodes in digraph are replaced by ‘variable names’ appropriately placed in boxes. The interpretations analysed (shown in ‘interpretive direct interaction matrix’) are presented on the side of the respective links to form TISM-based model. Final TISM model of identified variables has been shown in Fig. 2.

## Discussion on Findings

India has been one among the fastest growing economies, and its role and significance in the global economy are continuously increasing towards ‘powerful player position’ acquisition. In today’s dynamic business environment, every year numerous new products are launched in the marketplace to attract new customers. Nowadays, organizations use a number of measures/indices to understand better ‘value of the products as perceived by existing/prospective customers’ they produce and offer, like

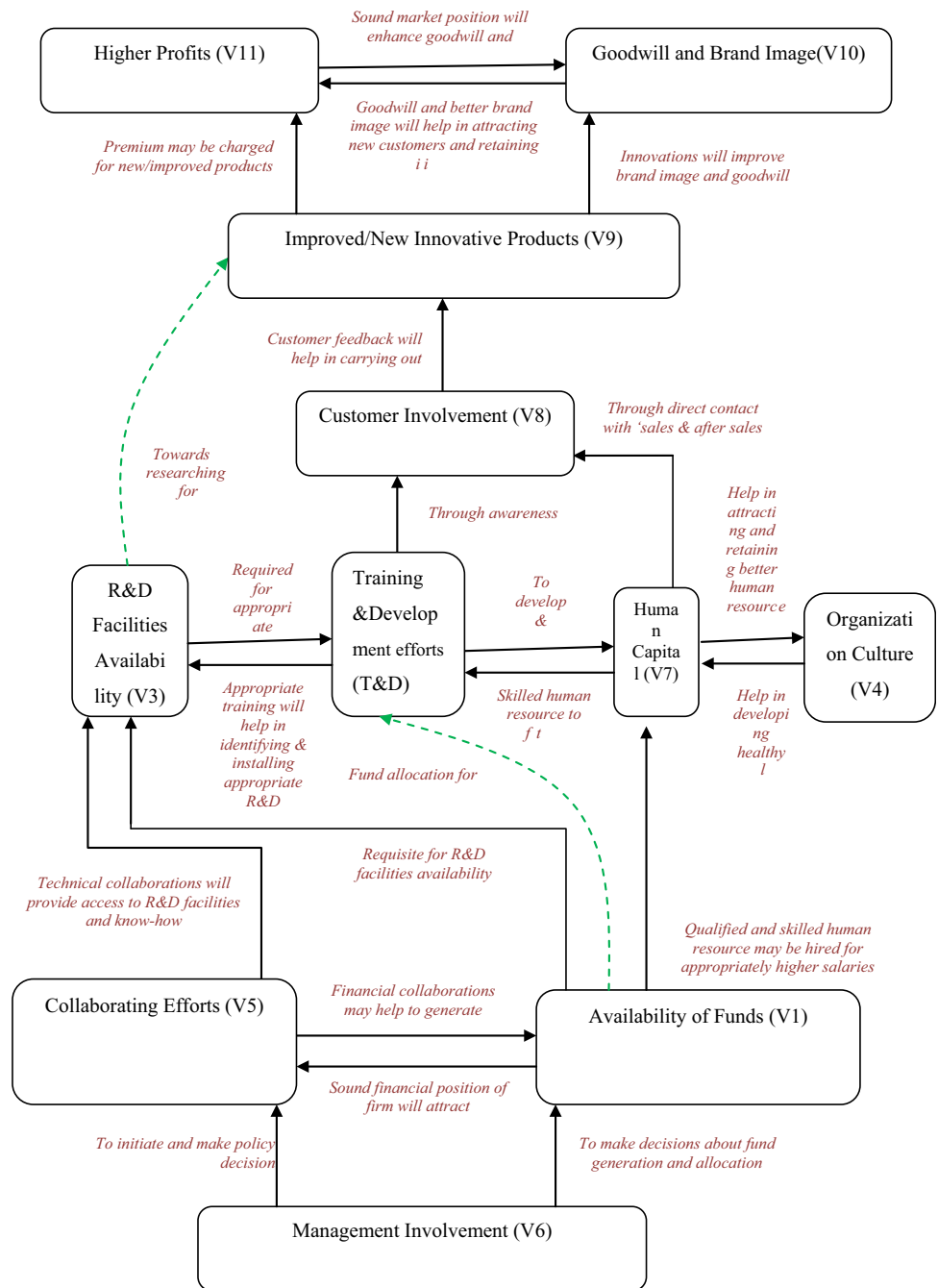
profitability, capitalization of the market, the introduction of new product and patents (Carayannis and Provanca 2008). Nowadays, product innovation management has become a significant weapon to be competitive and a means of organizations’ survival. The innovation capacity of firms may be determined by numerous factors relating to the firm’s internal environment and market environment, and creation and conversion of novel ideas into feasible products (useful and marketable) requiring higher inter-functional coordination and integration. The proposed TISM-based model, knowledge base and interpretations will help decision maker/practitioners to make complicated decisions to enhance product innovation management practices to take the competitive edge over competitor firms/supply chains.

Measurement of product innovation has been a critical area both for academics and practitioners. Our research has implications for academics and practitioners to carry out new theoretical as well as empirical analysis towards managing product innovation in India and other similar developing countries.

## Conclusions

In this paper, an attempt has been made to explore the area of product innovation management and its current status in India. In the present paper, a flexible system approach has been used for understanding requisites of product innovation management. Literature review has been used to identify important requisites and benefits of product innovation management. Important eight requisites (Availability of funds; Training and development; Research and development facilities; Organization culture; Collaborations; Management involvement, Human resources and Customer involvement) and three benefits (Improved/new innovative products; Goodwill and brand image; and Higher profits) of product innovation management in Indian organizations have been recognized through extensive review of the literature. AHP methodology has been used to rank these identified essential requisites and benefits of product innovation management. Further, TISM technique has been used to establish contextual relationships between various variables and their logic behind contextual relationships; and develop a hierarchy of variables of product innovation management. The developed TISM model will help towards a better understanding of product innovation management phenomenon by strong knowledge base generated and logic (interpretive) established by experts. ‘Higher profits’ and ‘Goodwill and brand image’ have been identified dependent top-level variables and ‘Management Involvement’ has been identified

**Fig. 2** TISM of variables of product innovation management



independent bottom-level variable of product innovation management.

In this paper, framework constructed may be useful in comprehensive measures construction of product innovation management and this article may facilitate academicians and researchers in carrying out their research work towards strengthening relatively less explored research area of product innovation management.

### Managerial Implications

This model suggests how these identified requisites of product innovation management are interrelated and their hierarchy levels will help organizations to understand in analysing relationships. This requisite that they have to improve upon to implement effective product innovation management to achieve benefits regarding performances; like improved/new innovative products; goodwill and



brand image; and higher profits in Indian perspective and the same can be generalized to developing countries.

**Limitations and Future Research Directions**

Although the literature had not been adequate in Indian perspective, the literature has been taken from other developed/developing countries; and a similar situation has been assumed for the Indian context. Though the model has been established using experts’ opinion; obviously experts’ opinion may vary depending upon expert’s perception.

In the future scope of work, sensitivity analysis may be applied to investigate the priority ranking stability of identified requisites of product innovation management in the present study. In the ISM/TISM methods, the number of pair comparisons to be made that increase exponentially with the increase in number of variables. Another challenge is the transitivity check on reachability matrix. In future work, a modified ISM/TISM processes may be used to address to the challenges by simultaneously carrying out transitivity checks along with the successive pair-wise comparisons (Sushil 2017).

Further, variables of product innovation management may be evaluated by utilizing appropriately other multi-criteria analytical methodologies such as DEMATEL, TOPSIS, ANP and results may be compared. Interpretive ranking process (IRP) may be further utilized to rank requisites of product innovation management concerning expected performance outcomes. Further, other dimensions of innovation may also be considered.

**Annexure 1: Interpretive Logic–Knowledge Base of Variables of PIM**

S. no.	Variable no	Paired comparison of variables	Y/ N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
V1—Availability of funds				
1	V1–V2	Availability of funds will influence/enhance Training and development efforts	Y	Fund allocation for T&D
2	V2–V1	Training and development efforts will influence/enhance Availability of funds	N	NA
3	V1–V3	Availability of funds will influence/enhance R&D facilities availability	Y	Requisite for R&D facilities availability

S. no.	Variable no	Paired comparison of variables	Y/ N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
4	V3–V1	R&D facilities availability will influence/enhance Availability of funds	N	NA
5	V1–V4	Availability of funds will influence/enhance Organization culture	Y	Transitive
6	V4–V1	Organization culture will influence/enhance Availability of funds	N	NA
7	V1–V5	Availability of funds will influence/enhance Collaborating efforts	Y	Sound financial position of firm will attract collaborating partners
8	V5–V1	Collaborating efforts will influence/enhance Availability of funds	Y	Financial collaborations may help to generate funds
9	V1–V6	Availability of funds will influence/enhance Management involvement	N	NA
10	V6–V1	Management involvement will influence/enhance Availability of funds	Y	To make decisions about fund generation and allocation
11	V1–V7	Availability of funds will influence/enhance Human capital	Y	Qualified and skilled human resource may be hired for appropriately higher salaries
12	V7–V1	Human capital will influence/enhance Availability of funds	N	NA
13	V1–V8	Availability of funds will influence/enhance Customer involvement	Y	Transitive
14	V8–V1	Customer involvement will influence/enhance Availability of funds	N	NA
15	V1–V9	Availability of funds will influence/enhance Improved/new innovative products	Y	Transitive
16	V9–V1	Improved/new innovative products will influence/enhance Availability of funds	N	NA
17	V1–V10	Availability of funds will influence/enhance Goodwill and brand image	Y	Transitive
18	V10–V1	Goodwill and brand image will influence/enhance Availability of funds	N	NA
19	V1–V11	Availability of funds will influence/enhance Higher profits	Y	Transitive
20	V11–V1	Higher profits will influence/enhance Availability of funds	N	NA

S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)	S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
<b>V2—Training and development efforts</b>					<b>V2–V10</b>				
	V2–V3	Training and development efforts will influence/enhance	Y	Appropriate training will help in identifying and installing appropriate R&D facilities		V2–V10	Training and development efforts will influence/enhance Goodwill and brand image	Y	Transitive
	V3–V2	will influence/enhance Training and development efforts Organization culture	Y	Required for appropriate training		V10–V2	Goodwill and brand image will influence/enhance Training and development efforts	N	NA
	V2–V4	Training and development efforts will influence/enhance Organization culture	Y	Transitive		V2–V11	Training and development efforts will influence/enhance Higher profits	Y	Transitive
	V4–V2	Organization culture will influence/enhance Training and development efforts	Y	Transitive		V11–V2	Higher profits will influence/enhance Training and development efforts	N	NA
	V2–V5	Training and development efforts will influence/enhance Collaborating efforts	N	NA	<b>V3—R&amp;D facilities availability</b>				
	V5–V2	Collaborating efforts will influence/enhance Training and development efforts	Y	Transitive		V3–V4	R&D facilities availability will influence/enhance Organization culture	Y	Transitive
	V2–V6	Training and development efforts will influence/enhance Management involvement	N	NA		V4–V3	Organization culture will influence/enhance R&D facilities availability	Y	Transitive
	V6–V2	Management involvement will influence/enhance Training and development efforts	Y	Transitive		V3–V5	R&D facilities availability will influence/enhance Collaborating efforts	N	NA
	V2–V7	Training and development efforts will influence/enhance Human capital	Y	To develop and polish skills		V5–V3	Collaborating efforts will influence/enhance R&D facilities availability	Y	Technical collaborations will provide access to R&D facilities and know-how
	V7–V2	Human capital will influence/enhance Training and development efforts	Y	Skilled human resource to foster		V3–V6	R&D facilities availability will influence/enhance Management involvement	N	NA
	V2–V8	Training and development efforts will influence/enhance Customer involvement	Y	Through awareness program		V6–V3	Management involvement will influence/enhance R&D facilities availability	Y	Transitive
	V8–V2	Customer involvement will influence/enhance Training and development efforts	N	NA		V3–V7	R&D facilities availability R&D facilities availability will influence/enhance Human capital	Y	Transitive
	V2–V9	Training and development efforts will influence/enhance Improved/new innovative products	Y	Transitive		V7–V3	Human capital will influence/enhance R&D facilities availability	Y	Transitive
	V9–V2	Improved/new innovative products will influence/enhance Training and development efforts	N	NA		V3–V8	R&D facilities availability will influence/enhance Customer involvement	Y	Transitive
						V8–V3	Customer involvement will influence/enhance R&D facilities availability	N	NA



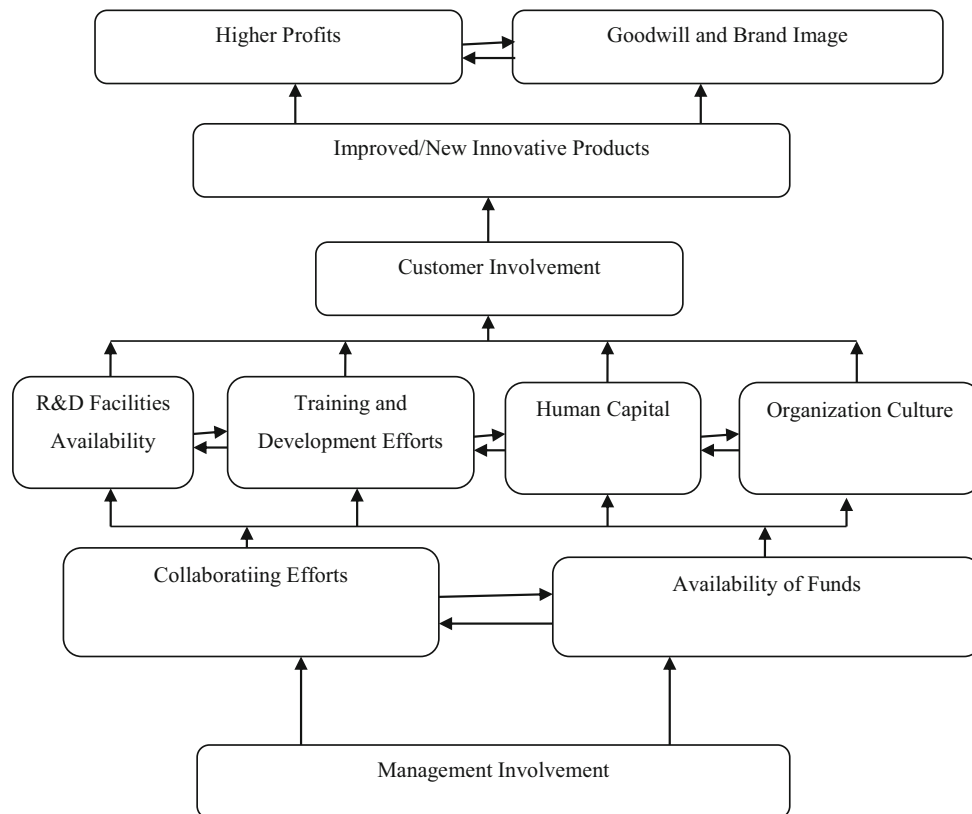
S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)	S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
	V3–V9	R&D facilities availability will influence/enhance Improved/new innovative products	Y	Towards researching for innovations		V4–V10	Organization culture will influence/enhance Goodwill and brand image	Y	Transitive
	V9–V3	Improved/new innovative products will influence/enhance R&D facilities availability	N	NA		V10–V4	Goodwill and brand image will influence/enhance Organization culture	N	NA
	V3–V10	R&D facilities availability will influence/enhance Goodwill and brand image	Y	Transitive		V4–V11	Organization culture will influence/enhance Higher profits	Y	Transitive
	V10–V3	Goodwill and brand image will influence/enhance R&D facilities availability	N	NA		V11–V4	Higher profits will influence/enhance Organization culture	N	NA
	V3–V11	R&D facilities availability will influence/enhance Higher profits	Y	Transitive		V5—Collaborating efforts			
	V11–V3	Higher profits will influence/enhance R&D facilities availability	N	NA		V5–V6	Collaborating efforts will influence/enhance Management involvement	N	NA
V4—Organization culture						V6–V5	Management involvement will influence/enhance Collaborating efforts	Y	To initiate and make policy decision
	V4–V5	Organization culture will influence/enhance Collaborating efforts	N	NA		V5–V7	Collaborating efforts will influence/enhance Human capital	Y	Transitive
	V5–V4	Collaborating efforts will influence/enhance Organization culture	Y	Transitive		V7–V5	Human capital will influence/enhance Collaborating efforts	N	NA
	V4–V6	Organization culture will influence/enhance Management involvement	N	NA		V5–V8	Collaborating efforts will influence/enhance Customer involvement	Y	Transitive
	V6–V4	Management involvement will influence/enhance Organization culture	Y	Transitive		V8–V5	Customer involvement will influence/enhance Collaborating efforts	N	NA
	V4–V7	Organization culture will influence/enhance Human capital	Y	Help in attracting and retaining better human resource		V5–V9	Collaborating efforts will influence/enhance Improved/new innovative products	Y	Transitive
	V7–V4	Human capital will influence/enhance Organization culture	Y	Assist in developing healthy culture		V9–V5	Improved/new innovative products will influence/enhance Collaborating efforts	N	NA
	V4–V8	Organization culture will influence/enhance Customer involvement	Y	Transitive		V5–V10	Collaborating efforts will influence/enhance Goodwill and brand image	Y	Transitive
	V8–V4	Customer involvement will influence/enhance Organization culture	N	NA		V10–V5	Goodwill and brand image will influence/enhance Collaborating efforts	N	NA
	V4–V9	Organization culture will influence/enhance Improved/new innovative products	Y	Transitive		V5–V11	Collaborating efforts will influence/enhance Higher profits	Y	Transitive
	V9–V4	Improved/new innovative products will influence/enhance Organization culture	N	NA		V11–V5	Higher profits will influence/enhance Collaborating efforts	N	NA

S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
<b>V6—Management involvement</b>				
	V6–V7	Management involvement will influence/enhance Human capital	Y	Transitive
	V7–V6	Human capital will influence/enhance Management involvement	N	NA
	V6–V8	Management involvement will influence/enhance Customer involvement	Y	Transitive
	V8–V6	Customer involvement will influence/enhance Management involvement	N	NA
	V6–V9	Management involvement will influence/enhance Improved/new innovative products	Y	Transitive
	V9–V6	Improved/new innovative products will influence/enhance Management involvement	N	NA
	V6–V10	Management involvement will influence/enhance Goodwill and brand image	Y	Transitive
	V10–V6	Goodwill and brand image will influence/enhance Management involvement	N	NA
	V6–V11	Management involvement will influence/enhance Higher profits	Y	Transitive
	V11–V6	Higher profits will influence/enhance Management involvement	N	NA
<b>V7—Human capital</b>				
	V7–V8	Human capital will influence/enhance Customer involvement	Y	Through direct contact with 'sales and after sales personnel.'
	V8–V7	Customer involvement will influence/enhance Human capital	N	NA
	V7–V9	Human capital will influence/enhance Improved/new innovative products	Y	Transitive
	V9–V7	Improved/new innovative products will influence/enhance Human capital	N	NA
	V7–V10	Human capital will influence/enhance Goodwill and brand image	Y	Transitive
	V10–V7	Goodwill and brand image will influence/enhance Human capital	N	NA

S. no.	Variable no	Paired comparison of variables	Y/N	In what way PIM variable will influence/enhance other PIM variable (with reason in brief)
	V7–V11	Human capital will influence/enhance Higher profits	Y	Transitive
	V11–V7	Higher profits will influence/enhance Human capital	N	NA
<b>V8—Customer involvement</b>				
	V8–V9	Customer involvement will influence/enhance Improved/new innovative products	Y	Customer feedback will help in carrying out innovations in products
	V9–V8	Improved/new innovative products will influence/enhance Customer involvement	N	NA
	V8–V10	Customer involvement will influence/enhance Goodwill and brand image	Y	Transitive
	V10–V8	Goodwill and brand image will influence/enhance Customer involvement	N	NA
	V8–V11	Customer involvement will influence/enhance Higher profits	Y	Transitive
	V11–V8	Higher profits will influence/enhance Customer involvement	N	NA
<b>V9—Improved/new innovative products</b>				
	V9–V10	Enhanced/new innovative products will influence/enhance Goodwill and brand image	Y	Innovations will improve brand image and goodwill
	V10–V9	Goodwill and brand image will influence/enhance Improved/new innovative products	N	NA
	V9–V11	Improved/new innovative products will influence/enhance Higher profits	Y	Premium may be charged for new/improved products
	V11–V9	Higher profits will influence/enhance Improved/new innovative products	N	NA
<b>V10—Goodwill and brand image</b>				
	V10–V11	Goodwill and brand image will influence/enhance Higher profits	Y	Goodwill and better brand image will help in attracting new customers and retaining existing ones
	V11–V10	Higher profits will influence/enhance Goodwill and brand image	Y	Sound market position will strengthen goodwill and brand image



## Annexure 2: ISM-based Model for Requisites and Benefits of Product Innovation



ISM based Model for Requisites and Benefits of Product Innovation

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### Key Questions

1. How can we model requisites of Production Innovation Management? Can we provide flexibility in this modelling tools.
2. What type of new work can be carried out for understanding the management of production innovation in specific reference to India.
3. What are the major limitations of TISM model so made in this paper and how can they may be improved?



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Journal, Journal of Cleaner Production, Resources Policy, Production Planning & Control, Benchmarking: An International Journal, International Journal of Logistics Systems and Management, Journal of Advances in Management Research, Journal of Industrial Engineering & Management, Journal of Industrial Engineering International and International Journal of Business Excellence, etc.); national journals (Productivity – National Productivity Council of India Journal, Udyog Pragati, Industrial Engineering – Indian Institution of Industrial Engineering Journal, etc.); and Conference of Repute. His specific areas of interest are operation management, optimization techniques, green supply chain management, sustainability, reverse logistics, technology management and renewable/sustainable energy technologies.