An empirical examination of critical barriers in transitions between technology push and demand pull strategies in manufacturing organizations

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Abstract

Purpose – The purpose of this paper is to examine critical barriers in transitions between technology push (TP) and demand pull (DP) strategies in Indian manufacturing industries for accomplishing sustainable development.
Design/methodology/approach – The factors that affect the transitions have been extracted and analyzed using factor analysis technique. For the purpose, various critical barriers are grouped together based on their relevance to TP-DP strategies. The responses to critical barriers have been collected from different Indian manufacturing organizations practicing TP-DP strategies, using a well-framed TP-DP questionnaire. Further, the responses are analyzed using factor analysis which improved the data interpretation.
Findings – Four latent factors were extracted from critical barriers and revealed that the manufacturing organizations face these barriers in transitions between TP-DP strategies. The recognition of the outcomes of critical barriers has been perceived to be substantial in the present context.
Originality/value – The research concludes that TP-DP strategies in Indian manufacturing industries encounter relevant critical barriers for accomplishing sustainable development. The outcomes of the study will help TP-DP practitioners, HR executives and organizational managers in manufacturing companies to develop clear understanding about the significant TP-DP strategies to be followed comprehensively for realization of sustainable development. The manufacturing organizations will be able to formulate and express their policies and issues in a more pertinent manner. Hence, the knowledge obtained from the empirical examination of critical barriers in transitions between TP and DP strategies will be helpful in improving the overall performance of manufacturing industries involved in the present study.

Keywords Manufacturing organizations, Factor analysis, Technology push, Demand pull, Critical barriers
Paper type Research paper

1. Introduction

A number of definitions are associated to technology, majority of which gives an account of manufacturing and product development industries. Martino (1983) stated that technology is overall utilization of means to provide basic commodities required for corporal sustainability and contentment. Zhao and Reisman (1992) contributed to the definition of technology as per social planning, management and business. On the whole, technology denotes a vast area of persistent application of dimensions of the real life. As per Gregson (1994) new technology is frequently used to displace the old one. Technology is a stimulant for change. However, the change that results, can be observed separately (as positive or negative) by different individuals or groups depending upon their approach with reference to change.

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The technology push (TP) strategy drives the product coordination philosophy of "if we build it, they will adopt it" owing to a number of fields. The TP strategies set up a discussion among technology managers about the fundamental principles and their driving forces. It was inferred that innovation is motivated by science and that consecutively stimulate technology (Chidamber and Kon, 1994).

Demand pull (DP) (market need) is a recognized need that stimulates innovation with the help of research and development (R&D). The industries manufacture the required products, do its marketing and fulfill the demand of its consumers. Moreover, DP inflation is likely to emerge when total demand overtakes total supply in an economy. This is broadly perceived as too much money chasing too few goods. The commitment of fulfilling the demand in time plays a substantial role in raising the standard of manufacturing firms and their overall sustainable development. As per Sastry (2011) business being the most significant sector, is the main strength of a market. Moreover, the industries impact the economy and employment, and the sustainable development favors business as well as society at large. As a result, numerous national companies have become global and strongly contended with established multinational players in the market. Yadav (2012) stated that trade is an essential benchmark among different aspects of globalization. It incorporates ever changing plans of the industries which are more extensive as compared to the previous formats.

Undoubtedly, numerous definitions of sustainable development are suggested over the time. World Commission on Environment and Development stated that, Sustainable development is a strategy of progress in which the utilization of assets, command on investments, arrangement of technological development and corporate revolution, are made persistent with subsequent and existing demand. Global rise in DP along with industrial revolution leads to competitive sustainable manufacturing. Sustainable development is escalating as a world-wide key perception that we must recognize to accommodate environmental, socio-economical and technological challenges. The progress of social security and sustainable development can only be achieved if humans are able to make overall employments and better living conditions for human ethical quality (Jovane *et al.*, 2008).

The manufacturing industries have witnessed many challenges in last few decades, involving drastic changes in innovative capability, corporate strategy, export orientation, transforming capabilities, customer satisfaction and other related issues. These challenges are compelling the manufacturing organizations to adopt innovative methodology to develop new products, and to exploit sustainable manufacturing tools and techniques efficiently. In other words, it is a matter of doing more with less, i.e. increasing productivity meanwhile utilizing minor resources and creating negligible waste (Bogue, 2014).

As per TP-DP practitioners and industrial managers, the field of TP-DP is continuously growing. The interactions among TP-DP strategies depend on industrial life cycles and status of local market (Choi, 2017). TP-DP strategies in manufacturing organizations bear complications due to critical barriers in transitions between them for achieving sustainable development. The focus of the present study is to analyze critical barriers in transitions between TP-DP strategies using factor analysis technique. Four factors have been extracted for various critical barriers by applying factor analysis on the responses obtained from 92 manufacturing organizations. In the present context, it has been investigated that the extracted factors of critical barriers have substantial effect on transitions between various TP-DP strategies.

2. Literature review

Today, universal rivalry has entered each and every portion of the planet and field of business (Koberg *et al.*, 2003). Prosperity is created through industrialization and development of economy is well recognized by growth of manufacturing corporations. Moreover, the prosperity of a country depends on the excellence of its production capacity

and that those who overcome manufacturing will eventually succeed in technological innovation (Yamashina, 2000).

In the resent paper, a literature review has been conducted on various strategies of TP and DP. Based on the review, the study identifies critical barriers in transitions among TP-DP strategies in manufacturing industries for realizing sustainable development. The categories of TP-DP strategies are discussed in the following sub-sections.

2.1 TP strategies

TP is regarded as a fundamental practice for the development and diffusion of technical improvements in manufacturing industries. TP uses an adopter to accept the technology (Drury and Farhoomand, 1999). The manufacturing industries prosper in the light of market needs, whereas according to technical experts the change in technology is the critical factor for development (Chidamber and Kon, 1994). To exploit the role of TP in manufacturing companies, we base our investigation on relevant articles and papers from various journals. The information is then linked with issues related to TP to enhance overall sustainability of manufacturing industries. The literature review is based on the issues discussed below.

2.1.1 Innovation. Innovation is a procedure of presenting unique temperament into the business sector or the market. It is the change of new learning into new items and services. As per the hierarchical setting, innovation might be related to definite modifications in effectiveness, viability, condition, and aggressiveness of the overall industry. Kocak *et al.* (2017) have reported that dedicated technology orientation leads to radical innovation, while responsive market regulation actively affects incremental innovation.

The concept of TP was primarily given by Schon (1967) as the basic motivation and driving force at the back of innovation of new technologies. Innovation is guided by science and hence impels technology. TP strategy originates from acknowledgment of new technological methods for improving the performance of manufacturing industries (Chau and Tam, 2000). The companies based on technology incorporate TP practices but these practices cannot be proclaimed as suitable or inaccurate to deal with sustainable development in manufacturing industries. It depends upon standardized framework, for instance, a particular business, an organization's history and so on (Brem and Voigt, 2009).

Four elements of innovation related to sustainable development were affirmed as; TP-DP, the National Arrangement of Development, Approach and Regulation; and Subsidizing. These elements found their relevance in the biotechnology sector. They are regarded as the drivers of innovation for the sustainable development in biotechnology industry. The study gives a remarkable knowledge of what drives and prevents innovation in the sustainability element (Liddle and El-Kafafi, 2010). Fatima (2017) investigated the role of globalization in the progression and circulation of technology across manufacturing industries operating in emerging and developing economies. The study analyzed the feasibility of different mediums of international technology transference, whether they push the firms operating in developing countries to innovate and as a result push them closer to the international technology sphere.

2.1.2 R&D. R&D is a common term for corporate or administrative development. R&D is an important segment of innovation and is arranged at the foremost position of the innovation lifecycle. Innovation and development expands on R&D and incorporates commercialization stages. There is a variation in exercises segregated as R&D, from organization to organization. Moreover, there are two essential models, associated with R&D division:

- a crew of engineers, specifically developing advanced products; and
- industrial scientists as crew tasked with applied exploration in experimental or technological fields.

Meyer (2000) has perceived that basic research is important for companies and patents play a significant role in measuring its relevance. The frequency of patents shows correlation between of science and technology. However, it is impractical to have all the technology patented. Laliene and Sakalas (2014) have developed a strategy to evaluate improvements in technology with respect to R&D. It was concluded that an individual firm can have its own zone of research which is diverse with respect to techniques used and manufactured products.

Albrecht *et al.* (2015) have proclaimed that the contribution of renewable energy is vital in reducing the carbon intensity around the world. The development of these technologies should thus be as compelling and proficient as could reasonably be expected. The researchers assessed the development costs for renewable energy technologies and relate them to research, development and demonstration (RD&D). It was inferred that government should critically assess these technologies and expand RD&D speculations to support next addition of technologies. Moreover, viable and productive support strategies for renewables are necessary to bring these technologies into the business.

2.1.3 Corporate strategy. Manufacturing, stated as conversion of materials and data into assets for the contentment of human wants, is the basic wealth-creating exercises in a country. Encouraging perfection in manufacturing arises as a vital objective of industry along with society (Chryssolouris *et al.*, 2013). Technology has led to reduced manufacturing times, which proves to be more fruitful for a fundamental format. It helps in lessening set-up and processing time variability (Li, 2003). The manufacturing sector plays a critical role in stimulating a more robust economy. Henceforth, an open economy is vital to securing economic growth in the manufacturing sector. However, there has been little progress for increasing the competitiveness of the manufacturing sector within the last several years. Furthermore, a lack of policy coordination among various government agencies is a barrier to increasing innovation and competitiveness in the manufacturing sector in the USA and India (Agarwal and Thiel, 2012).

According to Baumers *et al.* (2016), in the world of advanced manufacturing technology, additive manufacturing (AM) methods are manufacturing three-dimensional parts and products directly from raw material and 3D design data. The step by step process does not require the use of tools, molds or dies. Technology experts speculated that AM will have a serious monetary effect on the manufacturing sector and on the society at large. It was revealed that economies of scale are achievable in AM. The results reached are further examined under the diverse strategic demands posed by the market-pull and technology-push strategies which are both found in the AM industry.

Subsequent analysis of latest technology is pivotal for a sustainable and prosperous future. However, contiguous changes in the global markets impose challenges for long-term policy and strategy making in industries (Saritas *et al.*, 2016). Takakuwa and Veza (2014) have reported that technology transfer and international competitiveness are closely related. In Japan, many companies that once dominated manufacturing technology have lost their market share to foreign companies. Taticchi *et al.* (2013) have proclaimed that, the industrial societies are leading the development of technological frameworks for sustainable development in manufacturing industries. As per Wonglimpiyarat (2012), to fulfill the expressed market need it is important to understand the perspective of innovator in order to have benefits from a new technology. Additionally, the establishment of industry standards and customer base acts as a competitive advantage for the innovator. Gilgeous and Gilgeous (1999) have proclaimed that there are activities being practiced in industries which governs working condition of the business and contribute most to the manufacturing significance.

2.1.4 Export orientation. Marjit and Ray (2017) have exhibited that current years have been undergoing a growth in the literature of industrial heterogeneity and export decision-making in the ambience of productivity and relevant costs of exports in manufacturing firms.

Meil and Salzman (2017) have proclaimed that quick rise of the Indian economy, specifically in software development and services for the past ten years, has provoked a broad range of investigation toward its success. The spectacular growth of this industry has set a continuous growth in exports and profit in all segments. Seyoum (2004) has stated that the level of demand of high technology products in a country is a strong predictor of export performance and other variables like customer satisfaction. A proper clarification of this relation will assist industries to formulate proper strategies for encouraging overall growth and sustainable development.

Fernández-Mesa and Alegre (2015) have proclaimed that the management should make risky strategies toward exports in a company. Their study has highlighted the attitude of managers toward entrepreneurship to attain larger export proficiency. It has been concluded that entrepreneurial coordination is an administrative approach that increases exports when managers also play a significant role in organizational development and innovation. Being entrepreneurially oriented is significant, but it might not be sufficient for enhancing export performance if the company is not able to learn and innovate new technologies.

Leonidou *et al.* (2015) have presented a study related to export manufacturing companies which determines the indicators of export strategy and its impacts on export performance. It has been stated that with the rapid growth of problems related to environment, exporters are increasingly encountered with ecological challenges in their export operations. The research has confirmed the instrumental role of both external forces (competitive intensity) and internal factors (organizational green culture) in crafting an environmentally friendly export business strategy. It was concluded that product differentiation advantage is positively related to both export market performance and export financial performance.

2.2 DP strategies

An understanding of DP strategies uncovers that extremely constrained information is available concerning sustainable development activities toward harnessing essential requirements in the manufacturing industries. Thusly, in the current connection, a review of literature discussing various issues has been conducted in this part.

2.2.1 Government regulations. To compete globally, companies must become more efficient, flexible and customer oriented. The government plays a significant part in determining the competitiveness of firms. Furthermore, it provides supportive infrastructure and flexibility to firms that help them compete in the international market (Halachmi, 2002).

Ghisetti (2017) have analyzed that the government regulations play a substantial role in driving the adoption and diffusion strategies of sustainable manufacturing technologies. The issues related to environmental regulation were examined by Ashford and Heaton (1976). Their work is based on the subject related to environmental policies framed by the government and how it affects the DP. They focused on the fact that whether the long-term benefits from environmental policies are justified against the high short-term expenses. It was investigated that some issues are crucial enough to evaluate the costs and advantages of environmental control. The authors suggested that the environmental regulations may not only decrease the total cost to the society but may reduce prices as well, which may lead to rise in demand. Johnstone *et al.* (2010) have examined the impact of ecological activities on technological advancement in the field of renewable energy. They analyzed the patent information on a board of 25 nations over the period 1978-2003. It was found that social approach assumes a critical part in deciding patent applications of different products. It was inferred that distinctive sorts of approach instruments are effective for various renewable energy sources.

Gil-Garcia *et al.* (2014) have proposed that exercises that put resources into development to accomplish more active and versatile government strategies are described by smart government. However, there is no concurrence between emerging technology and development in the public sector. It leads to fluctuations in the price and demand of products. Aggregately, the researchers gave viewpoint on the strategy of smart governments and activities on how governments are opening up and changing administration activities to act more smartly. It was presumed that government could be seen as an imaginative blend of ever changing technology and development in the public division. At times the technical segment is the most crucial one, yet in different cases the technology is a minor part of progression of changes and advancements.

Hannon *et al.* (2015) have exhibited that the DP methodologies of government introduces an efficient method to fortify the administration-based plans of action, commonly known as product-service systems (PSS). It includes supply-based plans to fulfill social necessities in environmentally feasible way; however, the usage of PSS remain isolated due to some crucial obstructions. It was reasoned that the research strengthens the requirement for energy proficiency commitments that includes both energy suppliers and purchasers.

2.2.2 Unionized labor. Labor unions are perceived as representatives of laborers in numerous industries. Their activity is to provide advantages, proper wages and working circumstances to their workers and the union represents their members in case of any disputes with administration. The researchers relate the issues of unionized labor which the industries face with the rise in demand of their products.

Walker (1993) has proclaimed that the division of labor is an unnoticed classification of an established economy. In an industry, the workers prefer to adopt better methodology to build designed products to make the customers purchase better quality and lower-priced products. On the flipside, sometimes the labor union resists the changes in the existing products which may affect the demand. It was concluded that, an industry cannot turn its powers to the extreme good without an extensive, more ideal organization of the laborers and the working class. There are numerous ramifications of a union which may abuse the presence of company's labor conformity costs (Modesto and Thomas, 2001). The authors dissected the implications of aggregate bargaining in the vicinity of labor adjustment costs. It was inferred that conformity costs affect the pace of modification of employment and it is the presence or the nonattendance of a commitment capacity of the union that matters.

As per Bastos *et al.* (2009), the company-specific plans which decide the wages play a major role in the industry wage platform. It is demonstrated that both the company's income platform and the normal compensation paid are explicitly connected with the level of firm heterogeneity in the business. It was concluded that, it is important to maintain the salaries of the workers up to a certain level, so as not to face any wage negotiations during the high demand of the company's products. Aloi *et al.* (2009) have researched that different nations have contrast in their labor market organizations; one nation has a focused work market while the other is unionized. It was presumed that laborers must support dictatorship in a unionized nation, yet restricts it in the non-unionized nation. Lommerud *et al.* (2012) have proclaimed that the incentives are influenced by labor enterprise foundations in multinational ventures. If the laborers are synchronized, push for innovation exchange is partially administered by firm's desire to check trade union force. Higher union dealing with power prompts more technology exchange along with two unique measurements, expertise and quality.

2.2.3 Transforming capabilities. Research and innovation requires a discussion on advancing technologies in which comparisons with earlier technologies are often drawn. This leads to a transfer of assigned properties so that the latest technology develops as a derivative of the earlier one. Research plays an important role in developing new technologies in companies and is successfully able to handle major competitors in the market which stimulates the sustainable growth of a company (Torgersen and Fuchs, 2017). Timsit *et al.* (2015) have

stated that, in the current times considerable exercises have been done by manufacturing industries to reduce the manufacturing expenses and to improve the performance and quality by adopting strategic orientation. The two important strategic orientations are market pull (MP) and resource push (RP). The MP inclination highlights the formulation and maintenance of customer value and responding to market requirements. In contrast, the RP orientation gives priority to a company's internal capacities as the origin for its strategic achievements.

Ndubisi (2012) have proclaimed that, achievement of high quality and reliability standards demonstrates organizational capabilities which provide enormous advantages. Achieving high quality standards by acquiring and practicing latest technologies is the primary motive of manufacturing companies. Industries try to regulate the cost and strengthen their corporate strategies and worth by terminating unwanted deviation in quality of products and services.

2.2.4 Customer attributes. It was argued in 1960s, that demand stimulates the amount and management of innovation. The variations in markets give indication to industries to invest in innovation accordingly to entertain unmet demands of consumers and to work extensively on certain issues. Shifts in relative prices of products and geographic variation in demand affect the size of payoff in successful investments in new models and techniques (Nemet, 2009). Peters *et al.* (2012) reported how different organizational policies influence DP practices in domestic and foreign markets. It was inferred that bigger the domestic and foreign market, higher is a country's innovative output based on DP practices. Moreover, domestic market development established by DP practices prompts more innovative output in a nation than development in international markets.

Lubik *et al.* (2013) studied the strategic orientation of manufacturing start-ups and it was concluded that many of the start-ups beginning with DP practices shift toward TP orientation in their early development stages. Herrona and Braiden (2006) presented a model to execute and setup profitability change in a cluster of manufacturing companies. The methodology, which was consented to be included in an extensive study, was implemented on 15 manufacturing firms of all scales, the result of which is the capacity to relegate an exponential sustainable development. Stefano *et al.* (2012) recognized demand as an origin of innovation in manufacturing industries. The objective is to determine an extensive set of market facets that influence the attainment of innovation. It was concluded that DP is a significant practice to direct the path toward the right economic settings.

An adequate demand is truly able to pull technological change only when it is revealed by advanced users, able to furnish relevant knowledge levels to its customers. The increase in productivity of the challenging sectors is positively affected by derived demand in various sectors (Antonelli and Gehringer, 2015). Whilst TP practices have been dominating the area of study, attention is focused on DP technology transfer. After exploring important factors, it was concluded that capabilities of industries for articulating their technological needs are important for DP technology transfer. A logistic regression analysis was executed. It was observed that quality of needs-articulation has positive impact on substantial demand-led technology transfer. Certainly, the companies must know and should be able to precisely justify what technologies they need (Jun and Ji, 2016). Today's manufacturing scenario is illustrated by accelerated changes in market and enhanced competitive strategies. Majority of the companies are using similar manufacturing techniques, therefore the struggle is not only based on manufacturing approach, but on how strongly a firm governs technology apropos its consumers (Singla *et al.*, 2017).

3. Research methodology

An investigation has been conducted in medium as well as large scale manufacturing organizations practicing TP-DP strategies in India. The examination includes the critical

barriers in transitions between TP-DP strategies. In the present investigation, 92 manufacturing enterprises have been relevantly surveyed, to report the responses for critical barriers in transitions between TP-DP practices in manufacturing firms toward achieving sustainable development.

In order to analyze the critical barriers, a comprehensive "TP-DP questionnaire" has been framed (Appendix). To carry out the examination precisely, the questionnaire has been fabricated by executing a thorough literature review. It is then authenticated by scrutiny from consultants, scholars and TP-DP practitioners in various companies. To ascertain the purpose and potency of queries related to manufacturing industries, the questionnaire was pre-tested on an illustrated specimen of industries. The opinions taken from consultants, scholars, peers, TP-DP practitioners and managers in industries are integrated to make the questionnaire more significant.

At last, the data collected from the manufacturing organizations have been compiled and analyzed through factor analysis approach for obtaining concrete validations to present the factors related to critical barriers in transitions between TP-DP practices. The research methodology adopted for achieving the above-mentioned objectives has been illustrated in the block diagram shown in Figure 1.

Figure 2 shows the procedure followed in finalizing the TP-DP questionnaire.

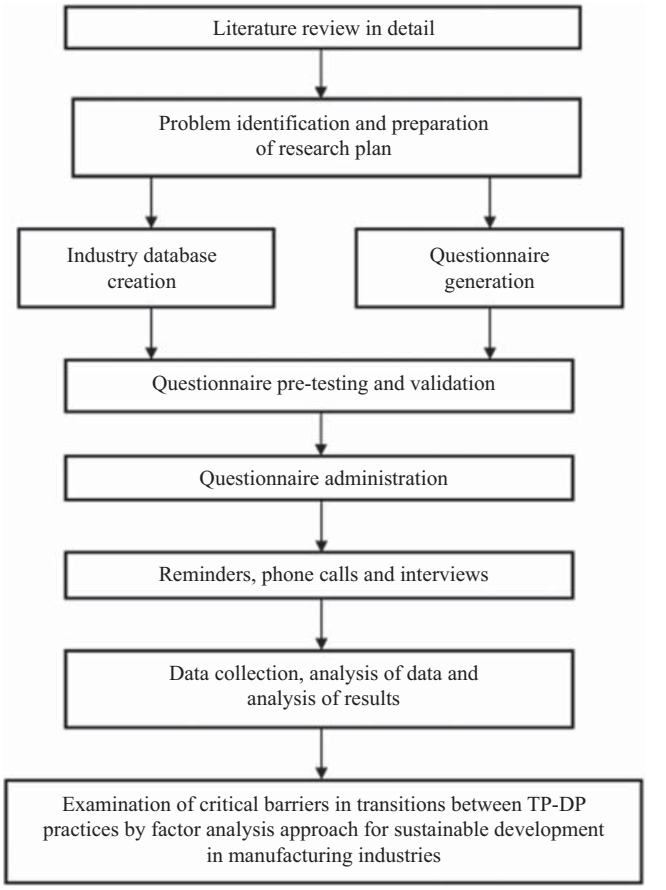

Figure 1.
Methodology employed for the investigation

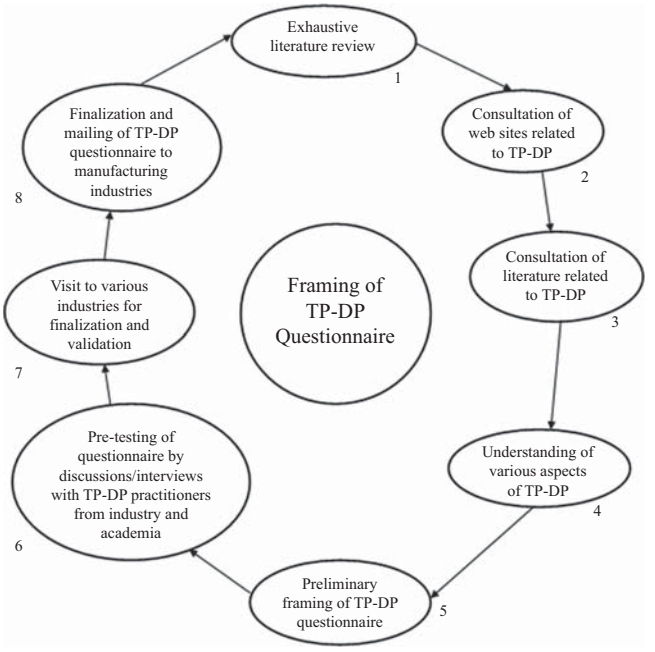

Figure 2.
Framing of TP-DP questionnaire

The formula adopted to find the sample size in the present survey is:

$$n = \frac{1.96^2 \times \sigma^2}{e^2}$$

where n is the size of the sample; σ, the standard deviation of the population; e, the percent of sampling error.

As per the responses obtained from the companies in the present study, standard deviation obtained was 22. Hence, with $\sigma = 22$ and $e = 5$, the sample size comes (n) out to be nearly 75. Since, valid responses from 92 (which is > 75) companies were obtained during the survey, out of a large number of industrial population. However, in consultation with industrial managers and technology representatives, it was found suitable to carry out the investigation further with a sample size of 92.

Furthermore, the questionnaire has been divided into four different sections. It starts with Section A which is based on general aspects of companies, which includes, name and address of company; respondent's details; main products of the company; main areas of business activity of company; present turnover; net profit; number of employees and market share; details of investment made in different areas; and characteristics of the company. In addition to this, Section B and C seek information about TP and DP strategies, respectively. Lastly, Section D provides data on critical barriers faced by the industries in transitions between TP and DP strategies.

The TP-DP questionnaire includes the following sections:

(1) Section A: general information of the company

- A1. Investment made in different areas as percentage of total expenditure during last year.
- A2. Characteristics of the company.

(2) Section B: technology push
- B1. Innovative capability.
- B2. Research and development (R&D).
- B3. Corporate strategy.
- B4. Export orientation.

(3) Section C: demand pull
- C1. Stringent implementation of government regulations.
- C2. Transforming capabilities.
- C3. Unionized labor.
- C4. Customer attributes.

(4) Section D: critical barriers in transitions between TP and DP Strategies.

4. Factor analysis to examine the behavior of critical barriers in transitions between TP- DP strategies

This section has been devoted to study the factors related to critical barriers in transitions between TP-DP strategies through factor analysis. Factor analysis is a statistical technique and has been applied in the current study to reduce a large set of variables (items) into fewer factors and each indicator has been put under one particular dimension to make it more significant. The technique has been performed on 23 indicators (critical barriers) as they are applicable to all respondents. In factor analysis, rotated component matrix using varimax with Kaiser normalization has been employed.

Various critical barriers in transitions between TP-DP strategies are portrayed in Table I. They are considered in the TP-DP questionnaire and then the responses are analyzed using factor analysis technique.

4.1 Results and analysis of factor analysis approach employed to critical barriers

Factor analysis approach has been applied on responses obtained from 92 manufacturing industries to 23 indicators extracted from the study. The results obtained from factor analysis are shown in Tables II and III. Table II reveals the results of KMO and Bartlett's test. The KMO index comes out to be 0.889, with 0.6 as recommended minimum value for an acceptable factor analysis (Pallant, 2005). Further, the value of KMO index in the present study is 0.889, which indicates that the sample size is satisfactory to apply factor analysis. Bartlett's test of Sphericity is also significant with approx. $\chi^2 = 1587.475$, degree of freedom $= 253.000$ at significance level of $p = 0.000$. The results from Table II exhibit that significant correlations exist among the variables under examination. Hence, all the tests reveal that data are fit for factor analysis.

For extraction of factors, principal component analysis using varimax rotation method with Kaiser normalization has been deployed in the study and results are tabulated in Table III. Table III displays the item loadings on each factor (loading can be viewed as the correlation co-efficient of that item with the corresponding factor). Positive loading implies that an item is contributing to the meaning of the corresponding factor and negative loading denotes the contribution of an item to opposite meaning of the corresponding factor. The four extracted factors are shown in second, third, fourth and fifth column of Table III, while the various corresponding items are portrayed in first column.

After extracting four factors, an appropriate name has been given to each factor on the basis of items loaded on a particular factor. Table IV portrays the factor wise list along with indicators

S.No.	Critical barriers
1	Cost of new technology acquisition
2	Cost of training and education
3	Problems with compatibility of equipment
4	Skill deficiency for transitions
5	Production management skill deficiency
6	Disruptions during transitions
7	Adverse effect on work flow
8	Adverse effect on work culture
9	Risk of failure to achieve financial targets
10	Inadequate flexibility in regulations
11	Workers' resistance
12	Increased maintenance expenses
13	Need for market expansion
14	Lack of financial justification
15	Lack of qualified personnel
16	Lack of information on technology
17	Lack of information on markets
18	Lack of marketing capabilities
19	Organizational rigidities within enterprise
20	Lack of appropriate sources of finance
21	Inability to devote staff to projects
22	Lack of industry wide standards
23	Likely obsolescence of technology

Table I.
Critical barriers in transitions between technology push and demand pull strategies

Kaiser-Meyer-Olkin measure of sampling adequacy		0.889
Bartlett's test of sphericity	Approx. χ^2	1587.475
	df	253.000
	Sig.	0.000

Table II.
KMO and Bartlett's test

in each factor. Factor loading attached to each indicator has also been shown in Table IV. Henceforth, four factors have been extracted through factor analysis which is responsible for examining the behavior of critical barriers in Transitions between TP-DP strategies for accomplishing sustainable development in manufacturing industries. The 4 factors are:

- organizational constraints (percent of variance = 22.900);
- operational constraints (percent of variance = 18.243);
- transitional constraints (percent of variance = 17.762); and
- financial constraints (percent of variance = 9.478).

In the present investigation, nine organizational constraints have been extracted. First, there is a lack of information on technology in Indian manufacturing industries. This is due to the fact that there is a gap between innovative ideas and technological advancements. Most Indian manufacturing industries stuck at the fundamental level of technological capabilities. Second, shortfall of information on domestic markets leads to redesigning of organizational structure to improve responsiveness and accountability. Third, the lack of marketing capabilities in industries is another barrier in transitions between TP-DP strategies. The manufacturing enterprises should be proficient enough to create internationally competitive marketing procedures for local as well as international markets. As a result of which, enhancement in export competitiveness could be acquired.

Item	Factor 1	2	3	4
16	*0.766*	0.416	0.229	0.014
17	*0.741*	0.434	0.279	0.082
18	*0.678*	0.338	0.427	0.042
14	*0.658*	0.180	0.037	0.295
9	*0.656*	0.211	0.226	0.164
10	*0.629*	0.139	0.266	0.187
15	*0.626*	0.516	0.209	−0.046
11	*0.556*	0.300	0.429	0.045
19	*0.475*	0.454	0.369	0.075
21	0.187	*0.820*	0.326	0.090
22	0.389	*0.795*	0.199	0.035
23	0.381	*0.753*	0.039	0.042
20	0.413	*0.695*	0.259	0.102
6	0.441	0.165	*0.725*	−0.007
4	0.063	0.447	*0.714*	0.190
7	0.535	0.169	*0.673*	0.045
5	0.160	0.480	*0.590*	0.210
12	0.337	0.098	*0.590*	0.071
8	0.500	0.357	*0.583*	0.014
3	0.104	0.065	*0.542*	0.407
1	0.153	−0.122	−0.164	*0.861*
2	−0.007	0.203	0.319	*0.812*
13	0.273	0.156	0.350	*0.581*

Table III.
Rotated component matrix – varimax with Kaiser normalization

Note: Italic values signifies factor loadings of four factors extracted in the study

Furthermore, there has been a lack of financial justification and risk of failure to achieve financial targets in Indian manufacturing organizations. However, the industries may seek financial aid from Government agencies to upgrade its technology and fulfill the demand of the customers in an efficient way. Other points state that there is an inadequate flexibility in regulations and lack of qualified personnel in the industries. This is because of the reason that there is a gap between industry and academia in India. There is a need to give emphasis on attracting and retaining talent. The infrastructure for technical and higher education must ensure an adequate supply of technically qualified personnel in industries. Although Indian organizations are served by a network of national laboratories and institutional infrastructure, these institutions usually fall short of quality as compared to those in developed nations, thereby putting India at a comparative disadvantage.

The last two barriers in organizational constraints include worker's resistance and organizational rigidities within the enterprise. It has been observed that companies face difficulties due to labor union while introducing new technology. The unionized labor resists the changes in existing products and do wage negotiations for overtime. There are organizational rigidities within the industries due to which the companies have not been able to exploit sustainable manufacturing tools and techniques effectively. The manufacturing industries must adopt competencies to quickly change over to new models.

In addition to this, operational constraints (percent of variance $= 18.243$) in the current study consists of four barriers. "Inability to devote staff to projects" is a major factor in this regard. Manufacturing industries in India are facing difficulties in allotting independent projects to its employees. The staff should work hard to tackle the projects which will enhance the company's as well as nation's dynamic competitive advantage. There is a lack of industry wide standards in Indian manufacturing organizations. Though national laboratories play a substantial role in designing and innovating technologically advanced

Item	Indicators (critical barriers)	Factor loadings
Factor 1: organizational constraints (percent of variance = 22.900)		
16	Lack of information on technology	0.766
17	Lack of information on markets	0.741
18	Lack of marketing capabilities	0.678
14	Lack of financial justification	0.658
9	Risk of failure to achieve financial targets	0.656
10	Inadequate flexibility in regulations	0.629
15	Lack of qualified personnel	0.626
11	Workers' resistance	0.556
19	Organizational rigidities within enterprise	0.475
Factor 2: operational constraints (percent of variance = 18.243)		
21	Inability to devote staff to projects	0.820
22	Lack of industry wide standards	0.795
23	Likely obsolescence of technology	0.753
20	Lack of appropriate sources of finance	0.695
Factor 3: transitional constraints (percent of variance = 17.762)		
6	Disruptions during transitions	0.725
4	Skill deficiency for transitions	0.714
7	Adverse effect on work flow	0.673
5	Production management skill deficiency	0.590
12	Increased maintenance expenses	0.590
8	Adverse effect on work culture	0.583
3	Problems with compatibility of equipment	0.542
Factor 4: financial constraints (percent of variance = 9.478)		
1	Cost of new technology acquisition	0.861
2	Cost of training and education	0.812
13	Need for market expansion	0.581

Table IV.
Extracted factors with indicators (critical barriers) and factor loadings

products in industries, Indian manufacturing industry has remained dependent for highly expensive and complicated technologies. The obsolescence of technology in one way or the other affects the transition between TP-DP strategies. This is due to the fact that absence of technology influences the manufacturers to respond effectively and quickly to the changing market demands globally. Lastly, the deficiency of sources of finance is another hindrance for Indian manufacturing industries. The better-financed companies are trying to develop their own products, to become innovators rather than copiers. This would help industries to overcome high entry barriers for innovation and technology.

"Transitional constraints" is the third factor evaluated in the present study containing seven indicators (critical barriers). First of all, disruptions during transitions between TP-DP strategies include the ability of the industries to maintain the quality and performance of products in diverse situations. Second, due to deficiency in skill for transitions the Indian companies continuously face problems while entering into new markets. Due to this fact, manufacturing industries face difficulties in accomplishing cost reduction/production improvements through technological exploits. Third, inability to change the product configuration during the manufacturing process to accommodate customer preferences put an adverse effect on work flow in the manufacturing firms. Fourth, production management skill deficiency is another barrier in transitions between TP-DP strategies. Industries lack established production facilities and equipment that meet regulatory standards in the country. Some Indian companies have also collaborated with foreign industries to improve their production capabilities to satisfy the consumers and develop new profit streams as well.

Moreover, increased maintenance expenses do not allow manufacturing organizations to transit quickly between TP-DP strategies. A number of engineering institutes throughout the country provide a steady stream of engineering graduates, whereas it is the responsibility of Bureau of Indian Standards (BIS) to regulate the activities related to the development and maintenance of industrial and other standards. The work culture in manufacturing firms also plays a significant role in the transitions. Indian industries have taken initial steps to rectify this situation by redefining its Science and Technology protocol, raising the expenditure on R&D and enforcing interactions among research institutions and industries. However, it still has a long way to go in catching up with the developed world and establishing product innovation culture in Indian manufacturing organizations. Lastly, the industries face problems with compatibility of equipment. The adoption and usage of technologies is quite low as compared to global standards. There is an acute need to design, develop and construct the machinery matching international standards in India.

The fourth factor evolved from the current analysis is financial constraints (percent of variance = 9.478) with three critical barriers in transitions among TP-DP strategies. First, upgrading manufacturing technology levels involves a high cost of new technology acquisition. In this regard, industries may seek financial help through Government policies for industrial sector. It is advisable to have own in-house R&D which creates enormous scope for institutional collaboration for development of new technology. Second, the cost of training and education hinders the transitions between TP-DP strategies. There are some key R&D institutes and testing facilities available in the country which are directly related to manufacturing industries, for instance, Council of Scientific & Industrial Research); Central Manufacturing Technology Institute; in-house R&D units of large enterprises; and BIS. The activities in these institutes include education and training (both academic and practical), R&D (academic, practical, product, process and input material related), and provision of services like testing and inspection. The last barrier in this regard is need for market expansion. The extension of market gives rise to product-mix strategies, explicitly for opportunities in export markets. The Indian manufacturing firms must re-design their core processes to dramatically improve efficiency and drive business value. It will lead to enhanced focus on quality and customer satisfaction.

5. Conclusions and managerial implications

Using factor analysis technique, important barriers that oppose the Transitions between TP-DP strategies for accomplishing sustainable development in manufacturing industries are analyzed in this paper. From the present research, it may be concluded that achieving sustainable development in manufacturing organizations is not an easy task. As per empirical study and results of factor analysis, organizational constraints have emerged as a major factor of critical barriers in transitions between TP-DP strategies. Henceforth, to overcome these barriers, manufacturing organizations need to support innovative thinking and make use of new ideas to deal with latest technology and emerging markets. In addition to this, the companies must establish well defined corporate strategies and flexibility in regulations for the overall development of workers and organization. Second, operational constraints, is another factor which corresponds to four critical barriers in transitions between TP-DP strategies. The examination depicts that in order to overcome these barriers manufacturing industries need to invest more in R&D so as to manufacture technologically sound products. Manufacturing enterprises must enhance their knowledge about latest technological developments to reduce the cost of existing products. Companies should manufacture products that minimize environmental impacts while maintaining social and economic benefits.

Furthermore, barriers in the factor, transitional constraints are identified as less critical in transitions between TP-DP strategies. To subjugate these barriers, manufacturing industries should effectively manage to deliver improved products in time as per the customer requirements and frequently introduce new and innovative products.

Additionally, companies should be capable enough to continuously enter into competitive markets and update and review their corporate strategies periodically. Lastly, financial constraints, is a factor having three barriers which furnish least obstruction in transitions between TP-DP strategies. However, present analysis shows that in order to overcome these barriers manufacturing industries must establish and execute an effective business sustainability plan. Moreover, companies may take support from government sponsored R&D programs to develop new products and technology, and to expand their market to a higher level.

The analysis reveals that results obtained are quite significant. As per the present context, all the barriers chosen and factor extracted plays a tangible role in transitions between TP-DP strategies. Hence these barriers must be overcome in order to have ingenious transitions among TP-DP strategies to achieve sustainable development in manufacturing industries.

Certainly, the present study has slight limitations also. First, no study in the past has reported exactly the same TP-DP strategies and critical barriers in transitions between them. Although all the strategies deployed in this study have been adapted from the extensive literature review, therefore, it is difficult to precisely correlate the factors with results of earlier studies. Another constraint is that the survey has been conducted in Indian manufacturing firms only. Hence, the results obtained from this analysis will need some modifications before applying to other geographic locations (countries). As the study has been conducted in Indian context only, the results may be applicable in similar economies. In future, studies can be conducted in other developing countries and developed economies to unfold some other barriers in transitions between TP-DP strategies.

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Appendix

SECTION A: GENERAL

COMPANY NAME				
COMPANY ADDRESS **(with pin code)**				
Respondent's Name & Designation				
Respondent's e-mail address and contact number				
Main products of the company (Please Specify)				
Main areas of business activity of company	Production Unit	Distribution Unit	Service Unit	Others
Present Turnover (rupees in crores)	5 – 10	10 – 50	50 – 100	> 100
Net Profit (as % of turnover)	< 5	6 to 10	11 to 20	>20
Number of Employees	< 200	201 – 500	501 – 1000	> 1000
Market Share (%)	< 10	10 – 25	26 – 40	> 40

A1. Investment made in the following areas as percentage of total expenditure during last year. (Please tick)

1	New machinery and equipment	1 to 20	21 to 40	41 to 60	> 60
2	Computer hardware and software	1 to 10	11 to 20	21 to 30	> 30
3	Research and development	1 to 10	11 to 20	21 to 30	> 30
4	Books, Journals and other literature	1 to 5	6 to 10	11 to 15	> 15

A2. Characteristics of the company. (Please tick)

1	How old is your company? (Years)	1 to 5	6 to 10	11 to 15	> 15
2	What is the organizational status of your plant?	Ancillary	Independent Unit	Branch	Head Office
3	What type of production is there in your plant?	Job order	Batch	Mass	Continuous
4	Number of main competitors in the market	0	1 to 5	6 to 10	> 10

SECTION B: TECHNOLOGY PUSH

B1. Innovative capability. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Does your company support innovative thinking and make use of new ideas?	1	2	3	4	5
2	Do innovative ideas support technological advancements?	1	2	3	4	5
3	During the last five years, did your company introduce new products to the market?	1	2	3	4	5
4	Is your company often first to introduce new products?	1	2	3	4	5
5	During the last five years, whether your company has introduced new or significantly improved methods of manufacturing?	1	2	3	4	5
6	To what extent the innovation is important in promoting the technological advancements in your company?	1	2	3	4	5
7	Does your company use innovative tools that make your product technologically sound?	1	2	3	4	5
8	Does your company imbibe innovative technologies frequently?	1	2	3	4	5
9	Does your company timely deliver new technology to the customers?	1	2	3	4	5

B2. Research and Development. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Does your company invest in R&D to develop new products?	1	2	3	4	5
2	Whether your company has government sponsored R&D to develop new products / technology?	1	2	3	4	5
3	Does R&D play a role in developing new technologies in your company?	1	2	3	4	5
4	Does your company conduct R&D programs to have knowledge about latest technological developments?	1	2	3	4	5
5	Does R&D carried out by your company help in reducing cost of existing products?	1	2	3	4	5
6	Does R&D exploit externally available information in development of new technologies?	1	2	3	4	5

B3. Corporate strategy. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Whether your company has successfully established well defined corporate strategy?	1	2	3	4	5
2	Does your company extensively and thoroughly follow these strategies?	1	2	3	4	5
3	Whether your corporate strategies indicate the frequent introduction of new and innovative products?	1	2	3	4	5
4	Does your corporate strategy emphasize on introduction of radically improved products?	1	2	3	4	5
5	Does your company update and review corporate strategies periodically?	1	2	3	4	5
6	Whether corporate strategies help in sustainable development of your company?	1	2	3	4	5
7	Does your company policies are designed to have clean technology innovations?	1	2	3	4	5
8	Does your company target a particular class of customers only?	1	2	3	4	5

B4. Export orientation. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Does your company introduce high-tech products in the international markets?	1	2	3	4	5
2	Does your company export high technology manufactured products at a fast rate?	1	2	3	4	5
3	Does your company export new products by substituting old ones?	1	2	3	4	5
4	Whether your company has expanded its global export to launch new and innovative products?	1	2	3	4	5
5	Has your company been successful in exporting technologically advanced products?	1	2	3	4	5
6	Whether export oriented activities are appropriately executed in your company?	1	2	3	4	5

SECTION C: DEMAND PULL

C1. Stringent implementation of government regulations. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Whether your products strictly comply with government regulations?	1	2	3	4	5
2	Is there any rise in demand of your complying products due to government regulations being stringently implemented?	1	2	3	4	5
3	Can your company fulfill the increased demand of complying products in time due to stringent implementation of government regulations?	1	2	3	4	5
4	Whether the stringent implementation of government regulations impacts the price and demand of your products?	1	2	3	4	5
5	Whether the stringent implementation of government regulations motivates you to enhance technological capabilities to meet the rise in demand of your products?	1	2	3	4	5
6	Does the stringent implementation of government regulations make impact on your corporate activity?	1	2	3	4	5

C2. Transforming capabilities. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Does your company effectively utilize available plant and equipment?	1	2	3	4	5
2	Does your company effectively plan and control production operations?	1	2	3	4	5
3	Whether your company has demonstrated enough competencies to quickly change over to new models?	1	2	3	4	5
4	Does your company use computerized information and control systems to provide information support and networking for production operations?	1	2	3	4	5
5	Do you need to re-manufacture your product as per the customer demands?	1	2	3	4	5
6	Is your company able to manufacture products at minimum possible costs?	1	2	3	4	5

C3. Unionized labor. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Whether unionized labor in your company resists the changes in existing products?	1	2	3	4	5
2	Whether the workers resist working with the new technology?	1	2	3	4	5
3	Do you face difficulties due to labor union while introducing new technology?	1	2	3	4	5
4	To what extent the labor participate in management decisions?	1	2	3	4	5
5	Do you face wage negotiations, carried out by workers for overtime?	1	2	3	4	5
6	Whether the workers maintain transparency in production?	1	2	3	4	5

C4. Customer attributes. (Please tick)

S.No.	Issues	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Whether the customers rush to buy your products, when their prices are slashed?	1	2	3	4	5
2	How often do you reduce the product cost?	1	2	3	4	5
3	Whether the customers are satisfied with the quality standards of your products?	1	2	3	4	5
4	Do you customize your products according to the customer requirements?	1	2	3	4	5
5	Does your company effectively manage timely delivery of products to its customers?	1	2	3	4	5
6	Whether your customers interact with the various web and mobile app services of your brand?	1	2	3	4	5

SECTION D: CRITICAL BARRIERS IN TRANSITIONS BETWEEN TECHNOLOGY PUSH AND DEMAND PULL STRATEGIES

Please indicate the importance of the following critical barriers in transitions between technology push and demand pull strategies in your company. (Please tick)

S.No.	Barriers	Not at all 1	Rarely 2	To some extent 3	Reasonably well 4	To a great extent 5
1	Cost of new technology acquisition	1	2	3	4	5
2	Cost of training and education	1	2	3	4	5
3	Problems with compatibility of equipment	1	2	3	4	5
4	Skill deficiency for transitions	1	2	3	4	5
5	Production management skill deficiency	1	2	3	4	5
6	Disruptions during transitions	1	2	3	4	5
7	Adverse effect on work flow	1	2	3	4	5
8	Adverse effect on work culture	1	2	3	4	5
9	Risk of failure to achieve financial targets	1	2	3	4	5
10	Inadequate flexibility in regulations	1	2	3	4	5
11	Workers' resistance	1	2	3	4	5
12	Increased maintenance expenses	1	2	3	4	5
13	Need for market expansion	1	2	3	4	5
14	Lack of financial justification	1	2	3	4	5
15	Lack of qualified personnel	1	2	3	4	5
16	Lack of information on technology	1	2	3	4	5
17	Lack of information on markets	1	2	3	4	5
18	Lack of marketing capabilities	1	2	3	4	5
19	Organizational rigidities within enterprise	1	2	3	4	5
20	Lack of appropriate sources of finance	1	2	3	4	5
21	Inability to devote staff to projects	1	2	3	4	5
22	Lack of industry wide standards	1	2	3	4	5
23	Likely obsolescence of technology	1	2	3	4	5

(SIGNATURE OF RESPONDENT WITH SEAL OF THE COMPANY)

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