A study of transitions between technology push and demand pull strategies for accomplishing sustainable development in manufacturing industries

Anuj Singla
Department of Mechanical Engineering,
Chandigarh Engineering College, Landran, India
APS Sethi
Department of Mechanical Engineering,
Baba Banda Singh Bahadur Engineering College, Fatehgarh Sahib, India, and
Inderpreet Singh Ahuja
Department of Mechanical Engineering, Punjabi University, Patiala, India

Abstract

Purpose – The purpose of this paper is to analyze transitions between technology push (TP) and demand pull (DP) strategies for accomplishing sustainable development in manufacturing industries.
Design/methodology/approach – The key aspects based on their relevance to TP-DP strategies have been extracted from literature review. The aspects were utilized to design a well-framed TP-DP questionnaire. An extensive survey in medium- and large-scale manufacturing industries operating in India has been executed through questionnaire. The responses to various factors were collected and the data obtained have been analyzed using analytical and graphical comparisions.
Findings – The recognition of the outcomes of transitions was perceived to be substantial. The research concludes that DP strategies dominates TP strategies in the present context. These strategies have emerged as a foundation for several development initiatives and actively support manufacturing industries in accomplishing sustainable development.
Originality/value – The analysis shows that TP-DP strategies in Indian manufacturing industries encounter significant transitions at different stages of their development.

Keywords Demand pull, Technology push, Transitions
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) contribute 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. The 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).

World Journal of Science, Technology and Sustainable Development
Vol. 15 No. 4, 2018
pp. 302-312

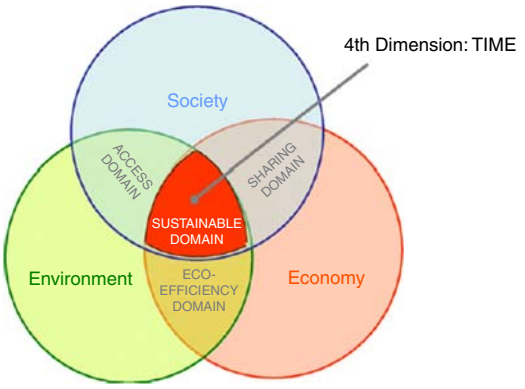
2042-5945
DOI 10.1108/WJSTSD-09-2017-0028

Demand pull (DP) (market need) is a recognized need that stimulates innovation with the help of research and development. 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. According to 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 (Brundtland, 1987) 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) (Figures 1 and 2).

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 transitions 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.



Source: Jovane *et al.* (2008)

Figure 1.
Fundamentals of sustainable development

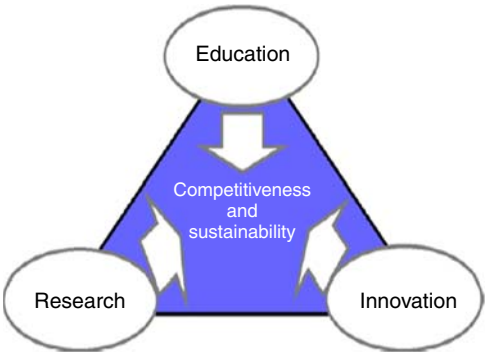


Figure 2.
The knowledge triangle

Source: Jovane *et al*. (2008)

The focus of the present study is to analyze transitions between TP-DP strategies empirical methods. In the present context, it has been investigated that the aspects identified have substantial effect on transitions between 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 over come manufacturing will eventually succeed in the technological innovation (Yamashina, 2000).

Technology Push (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).

Manufacturing, stated as conversion of materials and data into assets for the contentment of human wants, is the fundamental wealth-creating exercises in a country. Encouraging perfection in manufacturing arises as a vital objective of industry alongwith 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). According to Gilgeous and Gilgeous (1999), there are activities practiced in industries which governs working condition of the business and contribute most to the manufacturing significance.

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). 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). 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). 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.

It was argued in the 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. According to Hannon *et al.* (2015), DP strategies of government introduces an efficient methodology to fortify the administration-based plans of action, generally known as product-service systems. It includes demand-based practices to fulfill social needs in environmentally feasible way. It was reasoned that the research strengthens the requirement for energy proficiency commitments that includes both energy suppliers and purchasers. 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. As per Walker (1993) the division of labor is an unnoticed classification of an established economy. In an industry, the workers prefer to adopt better techniques to build products to make the customers purchase good quality products. On the other hand, 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.

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). Effective and efficient support strategies for renewables are vital in order to bring technological change into the market (Albrecht *et al.*, 2015). Technology transfer processes can be TP or DP. 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

In the present research, a questionnaire investigation approach has been deployed to seek information on the situation of TP-DP strategies in manufacturing industries. For the purpose, a comprehensive "TP questionnaire" has been fabricated by executing a thorough literature survey for accessing transitions between TP-DP strategies. The research has been conducted on medium- and large-scale manufacturing industries in India. The organizations were selected based on their annual turnover. Finally, valid responses from 92 companies were obtained. The study then analyzes the transitions among TP-DP strategies and explains the linkages by employing various comparisions. Figure 3 shows the methodology adopted for research.

TP questionnaire reveals issues related to TP-DP strategies in recognizing complete organizational objectives of manufacturing industries for achieving sustainable development. Figure 4 shows the procedure involved in finalizing the TP-DP questionnaire. A significant and an extensive questionnaire has been designed which covers various issues of TP and DP. The questionnaire has been utilized to attain details essential to attain the purpose of investigation.

4. Transitions between TP-DP strategies

It is very surprising to learn from the literature that, not much has been written about TP and DP strategies in manufacturing industries in less developed countries (as compared to developed countries) in general and India in particular. After the liberalization of Indian economy and globalization of trade, commerce, and industry, being initiated in 1991, there

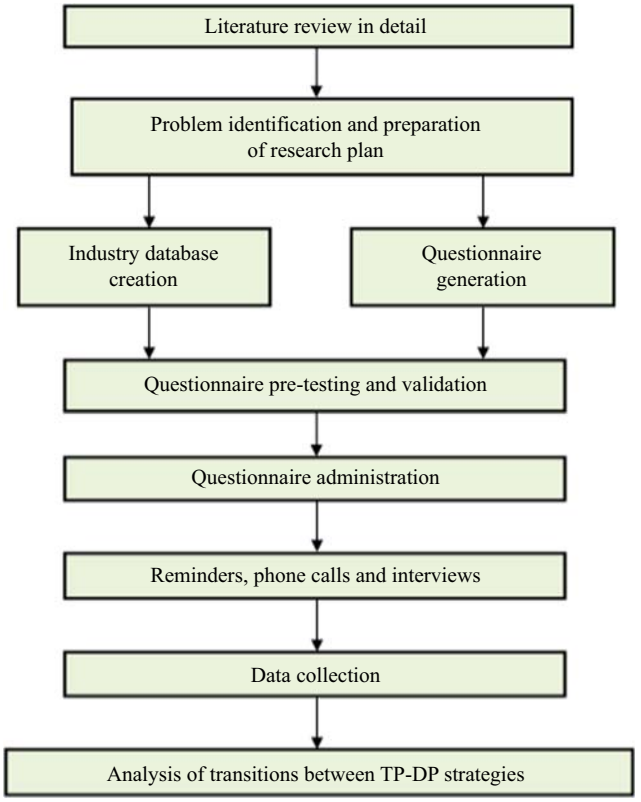


Figure 3.
Methodology employed for the investigation

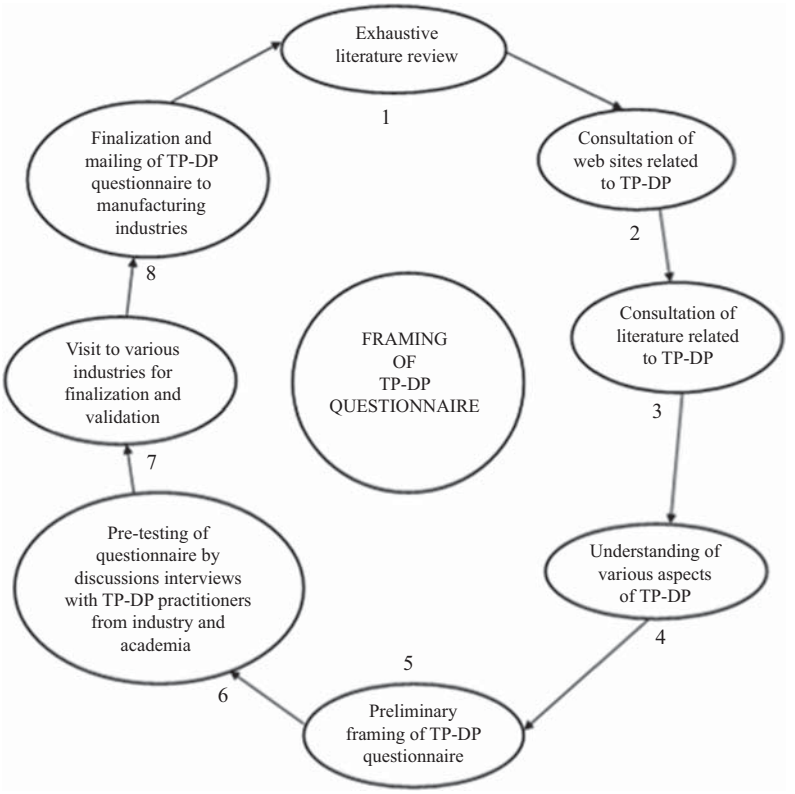


Figure 4.
Framing of TP-DP questionnaire

had been a continuously increasing competition in Indian manufacturing industries. Indian technology researchers have started penning down the things but only in a very limited domain. There have been sufficient cases of technology management available in the literature, but these do not give any insights in transition between TP and DP strategies. There has been a lot of research done on adoption of technology, but the research regarding the linkages between TP-DP strategies and sustainable development is missing. So, a research has been planned to develop a conceptual framework to explore shifts between TP-DP strategies for sustainable development in manufacturing enterprises.

As traditional manufacturing is gradually outsourced to lower-cost areas, strategy makers seek leadership in emerging firms by motivating innovative industries to follow competitiveness. Developing companies are those, where a technology prevails, but a new technology suppresses the current value chain to fulfill customer demands. Therefore, this field exhibits a proof of both TP and DP strategies. There is a need to understand TP and DP orientations in manufacturing industries, explicitly investigating how and why these orientations shifts.

TP-oriented companies possess unique technologies where an end user and value chain to the customers has not been secured. A company trying to advertize a novel technology, may see potential benefits over comparable ones (Schumpeter, 1928). Majority of the TP-oriented companies start with a new technology with no market demand in view and they only focus entirely on developing that technology. Some experimental marketing often takes place and the industry tends to remain inward until something initiates a transition. A developing technology has numerous applications in different markets. In the present context, industries have

restricted market know-how and rely on past knowledge only. The external forces may tend to cause the firms to start accepting market oriented practices. The initial transition against DP strategy may be due to recognition of actual vs assumed customer demands or a radical transformation in management. The market may motivate firms to manufacture new products that are sustained by its current technology. It appears that these companies mainly concentrate on technological advancement until some catalyst, generally external, demands a transition.

On the flipside, each DP-oriented company acquires its basic product concept from chances its management anticipated in the market. To advertise the concept, firm attains essential technology by developing it or by purchasing it. A reaction of market is then procured in development stage of product and is sold in the market from which the industry had acquired the idea. As and when the product is spread in the market and customer feedback is received, enterprises shift their concentration to their technology. Industries wish to enhance their prime technology to boost competitiveness and to amend the product better fit into the market; and to provide desired complementary innovations. The transfer of technology focus depicts that these companies have started to compete their technologies with other market requirements (Freeman 1982). Their technical know-how motivates them to check for further development of existing technology. This requires a substantial modification of policies toward improving the technology. In some of the developed companies, the two strategies have shown the signs of co-existence.

5. Analysis of transitions between TP-DP strategies

This section is devoted to analyze the aspects related to TP-DP strategies for sustainable development in manufacturing industries. Table I shows the questions (with respect to aspects) developed for the TP-DP questionnaire after an extensive literature review and discussions with TP-DP practitioners. The responses to these questions has multiple options where the respondent will select the preferred one (may be more than one to each question). The responses received have been used to study the transitions between TP-DP strategies. Figure 5 graphically portrays the responses obtained from industries to various aspects of TP-DP strategies.

It is evident from Table I that TP strategies are practiced dominantly whenever:

- there is a decrease in a product's market share;
- government norms have to be stringently followed;

Table I. Percentage of transitions of TP-DP strategies

S. No.	Aspects	Responses to TP	Responses to DP	TP (%)	DP (%)
1	Key features of corporate strategy	58	95	37.91	62.09
2	Availability of strong R&D capability	52	77	40.31	59.69
3	Utilization of new product innovation capabilities	64	69	48.12	51.88
4	Strategy followed when export orientation is on a rise	60	65	48.00	52.00
5	Strategy to utilize new knowledge accumulated	52	82	38.81	61.19
6	Strategy followed when level of competition starts increasing	52	78	40.00	60.00
7	Strategy if demand of products increases	38	82	31.67	68.33
8	Strategy if there is a decrease in product's market share	72	57	55.81	44.19
9	Strategy if government norms have to be stringently followed	66	54	55.00	45.00
10	Utilization of large existing manufacturing infrastructure	61	63	49.19	50.81
11	Labor unions support	52	79	39.69	60.31
12	Strategy on unsatisfied needs of customers	56	72	43.75	56.25
13	Strategy on fall in profit margins	71	48	59.66	40.34
14	Strategy opted to enhance business performance	81	61	57.04	42.96
15	Strategy if productivity starts decreasing	68	75	47.55	52.45
16	Approach if customer satisfaction is not up to the mark	32	116	21.62	78.38

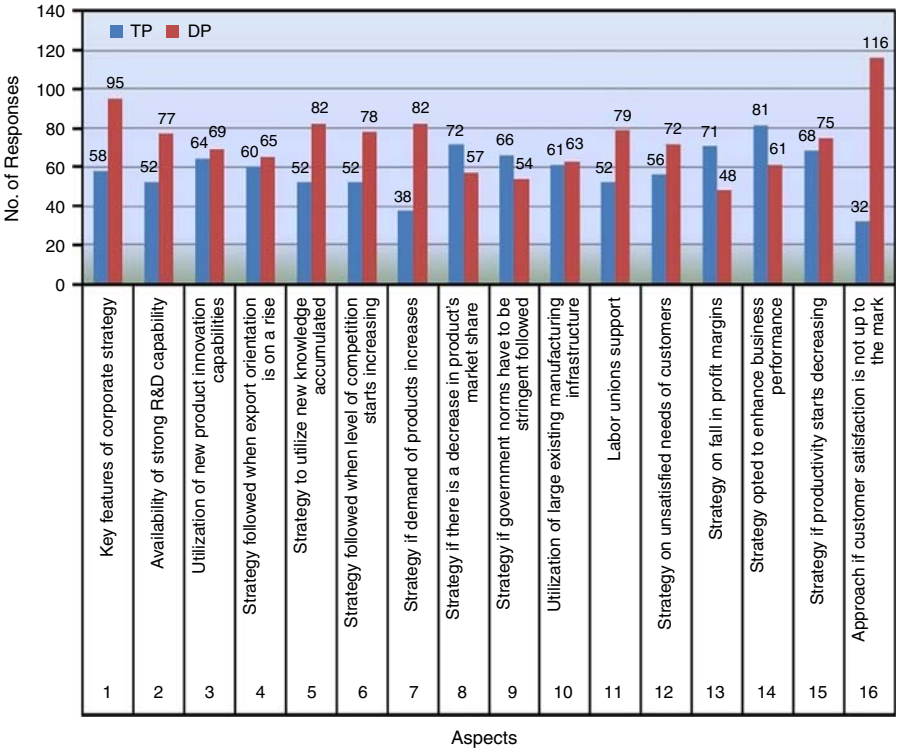


Figure 5.
Responses of companies to various aspects of TP-DP strategies

- the profit margins fall; and
- it is desired to enhance business performance.

Under these circumstances there are more chances that a company may transit toward TP strategies.

Whenever there is a decrease in a product's market share and a company wishes to enhance it, there are 55.81 percent indications that it follows TP strategy. However, there are still 44.19 percent chances that the company may prefer DP strategies. Table I portrays that, if the government norms have to be stringently followed for manufacturing the products, industries launch new complying products into the market, which shows 55 percent orientation of industries toward TP policies. Furthermore, chances of shifting of Indian manufacturing industries toward TP strategies are 59.66 percent if there is a fall in profit margins. However, 40.34 percent prospects are that the industry may adopt DP strategies. To enhance the business performance, manufacturing enterprises actively seek innovative ideas and hence orient toward TP strategies with 57.04 percent contingency.

On the other hand, Table I portrays that DP strategies are practiced significantly when:

- key features of corporate strategy help improve product's quality;
- a strong R&D capability is available;
- new product innovation capabilities are effectively utilized;
- export orientation is on a rise;
- new knowledge is accumulated;

- level of competition starts increasing;
- demand of products increases;
- a large manufacturing infrastructure exists;
- labor unions support the company;
- unsatisfied needs of customers are recognized;
- productivity starts decreasing; and
- customer satisfaction is not up to the mark.

Under these aspects there are greater prospects that an industry may orient toward DP strategies.

It has been observed from the analysis that if key features of corporate strategy help revamp product's quality, there is 62.09 percent possibility that companies adopt DP strategies. However, there are still 37.91 percent chances that the companies may favor TP strategies. As per Table I, when a strong R&D capability is available, industries manufacture products at low cost, which shows 59.69 percent orientation of industries toward DP. When new product innovation capabilities are effectively utilized, Indian manufacturing enterprises transit toward DP strategies with 51.88 percent contingency. The chances of companies to orient toward DP practices are 52.00 percent when export orientation is on a rise. The results show that if new knowledge is accumulated by industries, there are 61.19 percent indications that they will follow DP policies. When the level of competition starts increasing, manufacturing enterprises provide improved services and offers to the consumers and hence orient toward DP strategies with 60.00 percent chances.

In addition to this, the possibility of companies to adopt DP policies is 68.33 percent if the demand of products increases. However, there are still 31.67 percent chances that the company may prefer TP strategies. The study reveals that companies almost equally orient toward DP (50.81 percent) and TP (49.19 percent) strategies, when they possess a large manufacturing infrastructure. When labor unions support manufacturing industries, there exist 60.31 percent contingency to follow DP strategies. It has been observed that, to fulfill unsatisfied needs of customers, chances of companies to practice DP policies are 56.25 percent. If the productivity in a company starts declining, there is a possibility of 52.45 percent that it will adopt DP strategies. Lastly, prospects of shifting of Indian manufacturing industries toward DP strategies are 78.38 percent when customer satisfaction is not accomplished. Still, 21.62 percent percent chances are that the industries may adopt TP strategies.

6. Conclusions

Certainly, the study exhibits that, ideally, firms should balance TP and DP strategies inside their policies (Nemet, 2009; Mowery and Rosenberg, 1979), whereas in less developed economies, manufacturing industries usually lack in resources to concentrate on both instantly. TP-oriented firms generally shift to DP strategy because of new partners and shifts in decision maker's preferences, normally due to monetary constraints imposed by longer starting times. On the other hand, most of the companies starting with a DP strategy might shift toward a TP orientation because early market experiences necessitate the improvement in operations to raise output or to fulfill a demand for technologically sound products. It is evident from the analysis that out of 16 aspects retrieved from literature review, 12 aspects (> 50 percent) have shown their orientation toward DP strategies, whereas only four conditions (> 50 percent) transit toward TP policies. Hence, DP strategies dominates TP strategies in the present study. The results of the present research shall help companies in successful transition between, and later balance, these strategies; and managing manufacturing, outsourcing and scaling-up decisions.

Hence in the present study, statistical analysis has been used for drawing relevant inferences of transitions between TP-DP strategies. For future work, some case studies may provide a deep

insight into the problem by giving real scenario of the industrial situation. Synthesis of the learning issues of both empirical studies and case studies will help evolve a management process using qualitative methods like analytic hierarchy process and fuzzy set theory. An implementation plan can be evolved to manage the challenging industrial situations.

References

Albrecht, J., Laleman, R. and Vulsteke, E. (2015), "Balancing demand-pull and supply-push measures to support renewable electricity in Europe", *Renewable and Sustainable Energy Reviews*, Vol. 49, pp. 267-277.

Antonelli, C. and Gehringer, A. (2015), "Knowledge externalities and demand pull: the European evidence", *Economic Systems*, Vol. 39 No. 4, pp. 608-631.

Bogue, R. (2014), "Sustainable manufacturing: a critical discipline for the twenty-first century", *Journal of Assembly Automation*, Vol. 34 No. 2, pp. 117-122.

Brem, A. and Voigt, K. (2009), "Integration of market pull and technology push in the corporate front end and innovation management-insights from the German software industry", *Journal of Technovation*, Vol. 29 No. 5, pp. 351-367.

Brundtland (1987), *Our Common Future, World Commission on Environment and Development*, Oxford University Press, Oxford.

Chau, P.Y.K. and Tam, K.Y. (2000), "Organizational adoption of open systems: a 'technology-push, need-pull' perspective", *Journal of Information & Management*, Vol. 37 No. 5, pp. 229-239.

Chidamber, S.R. and Kon, H.B. (1994), "A research retrospective of innovation inception and success: the technology-push demand-pull question", *International Journal of Technology Management*, Vol. 9 No. 1, pp. 1-27.

Choi, H. (2017), "Technology-push and demand-pull factors in emerging sectors: evidence from the electric vehicle market", *Industry and Innovation*, pp. 1-20, doi: 10.1080/13662716.2017.1346502.

Chryssolouris, G., Mavrikios, D. and Mourtzis, D. (2013), "Manufacturing systems: skills & competencies for the future", *Journal of Procedia CIRP*, Vol. 7, pp. 17-24.

Drury, D.H. and Farhoomand, A. (1999), "Information technology push/pull reactions", *Journal of Systems and Software*, Vol. 47 No. 1, pp. 3-10.

Fatima, S.T. (2017), "Globalization and technology adoption: evidence from emerging economies", *The Journal of International Trade & Economic Development*, Vol. 26 No. 6, pp. 724-758.

Freeman, C. (1982), *The Economics of Industrial Innovation*, MIT Press, Cambridge, MA.

Gilgeous, V. and Gilgeous, M. (1999), "A framework for manufacturing excellence", *Journal of Integrated Manufacturing Systems*, Vol. 10 No. 1, pp. 33-44.

Gregson, K. (1994), "Technology – friend or foe?", *Journal of Work Study*, Vol. 43 No. 8, pp. 23-24.

Halachmi, A. (2002), "Performance measurement and government productivity", *Work Study*, Vol. 51 No. 2, pp. 63-73.

Hannon, M.J., Foxon, T.J. and Gale, W.F. (2015), "'Demand pull' government policies to support product-service system activity: the case of energy service companies (ESCos) in the UK", *Journal of Cleaner Production*, Vol. 108, Part A, pp. 900-915.

Herrona, C. and Braiden, P.M. (2006), "A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies", *International Journal of Production Economics*, Vol. 104 No. 1, pp. 143-153.

Jovane, F., Yoshikawa, H., Alting, L., Boer, C.R., Westkamper, E., Williams, D., Tseng, M., Seliger, G. and Paci, A.M. (2008), "The incoming global technological and industrial revolution towards competitive sustainable manufacturing", *Journal of CIRP Annals – Manufacturing Technology*, Vol. 57 No. 2, pp. 641-659.

Jun, Y. and Ji, I. (2016), "Demand-pull technology transfer and needs-articulation of users: a preliminary study", *Procedia Computer Science*, Vol. 91, pp. 287-295.

Koberg, C.S., Detienne, D.R. and Heppard, K.A. (2003), "An empirical test of environmental, organisational and process factors affecting incremental and radical innovation", *Journal of High Technology Management Research*, Vol. 14 No. 1, pp. 21-45.

Li, J. (2003), "Improving the performance of job shop manufacturing with demand-pull production control by reducing set-up/processing time variability", *International Journal of Production Economics*, Vol. 84 No. 3, pp. 255-270.

Lubik, S., Lim, S., Platts, K. and Minshall, T. (2013), "Market-pull and technology-push in manufacturing start-ups in emerging industries", *Journal of Manufacturing Technology Management*, Vol. 24 No. 1, pp. 10-27.

Martino, J.P. (1983), *Technological Forecasting for Decision – Making*, 2nd ed., North Holland, New York, NY.

Mowery, D. and Rosenberg, N. (1979), "The influence of market demand upon innovation: a critical review of some recent empirical studies", *Research Policy*, Vol. 8 No. 1, pp. 102-153.

Nemet, G.F. (2009), "Demand-pull, technology-push, and government led incentives for non-incremental technical change", *Journal of Research Policy*, Vol. 38 No. 5, pp. 700-709.

Peters, M., Schneider, M., Griesshaber, T. and Hoffmann, H.V. (2012), "The impact of technology push and demand-pull policies on technical change: does the locus of policies matter?", *Journal of Research Policy*, Vol. 41 No. 8, pp. 1296-1308.

Sastry, T. (2011), "Exploring the role of business in society", *Journal of IIMB Management Review*, Vol. 23 No. 4, pp. 246-256.

Schon, D. (1967), *Technology and Social Change*, Delacorte Press, New York, NY.

Schumpeter, J. (1928), "The instability of capitalism", *The Economic Journal*, Vol. 38 No. 151, pp. 361-386.

Singla, A., Ahuja, I.P.S. and Sethi, A.P.S. (2017), "The effects of demand pull strategies on sustainable development in manufacturing industries", *International Journal of Innovations in Engineering and Technology*, Vol. 8 No. 2, pp. 27-34.

Stefano, G.D., Gambardella, A. and Verona, G. (2012), "Technology push and demand pull perspectives in innovation studies: current findings and future research directions", *Journal of Research Policy*, Vol. 41 No. 8, pp. 1283-1295.

Walker, R.A. (1993), "The hidden dimension of industrialization: an expanding division of labour", *Journal of Futures*, Vol. 25 No. 6, pp. 673-693.

Yadav, P. (2012), "India's changing trade pattern in the process of globalization", *Procedia of Social and Behavioral Sciences*, Vol. 37, pp. 157-166.

Yamashina, H. (2000), "Challenge to world class manufacturing", *International Journal of Quality and Reliability Management*, Vol. 17 No. 2, pp. 132-143.

Zhao, L. and Reisman, A. (1992), "Towards meta research on technology transfer", *IEEE Transactions of Engineering Management*, Vol. 39 No. 1, pp. 13-21.

Corresponding author
Anuj Singla can be contacted at: anujsingla86@gmail.com