ANALYSIS OF DETERMINANTS OF PROCESS INNOVATION IN SMES IN CUTTING TOOL INDUSTRIES

A thesis report submitted in partial fulfillment of
the requirement for the award of the degree of

MASTER OF ENGINEERING
(PRODUCTION AND INDUSTRIAL ENGINEERING)

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DECLARATION

I, **JUGRAJ SINGH** hereby declare that the work which is being presented in this report entitled, '**Analysis of determinants of process innovation in SMEs in Cutting Tool Industries**' by me in partial fulfillment of the requirements for the award of degree of Master of Engineering in Production and Industrial Engineering from MED, Thapar University is an authentic record of my own work carried under the supervision of Sh. Supreet Bhullar, Associate Professor, Mechanical Engineering Department, Thapar University, Patiala.

The matter presented in this report has not been submitted in any other University/Institute for the award of Master of Engineering or any other degree.

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This is certified that the above statement made by the candidate is correct to best of my knowledge.

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I take pride of myself being son of ideal parents for their everlasting desire, sacrifice affectionate blessings, and my help, without which it would not have been possible for me to complete my studies.

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ABSTRACT

Understanding how the determinants of process innovation affect the SMEs growth. The main contribution of this work is to analyze the determinants of process innovation in SMEs. This preliminary study considers a combination of factors to study the impact of these on process innovation in SMEs in the cutting tool industry, thereby enhancing our knowledge of success factors in the innovation of process of SMEs. To accomplish this, it explores how the innovation process in SMEs firms depends on Research & Development (R&D) and the use of external sources. Data collected through a structured questionnaire was analyzed using statistical tools to establish correlation between dependent and independent variables. The results support that the activities such as advanced machinery, external knowledge, training, new machinery are crucial to understanding the process innovation in the firm.

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INTRODUCTION

1.1 INNOVATION

‘Innovation is defined as a process by which varying degrees of measurable value enhancement is planned and achieved, in any commercial activity (NKC, 2007). This process may be breakthrough or incremental, and it may occur systematically in a company or sporadically; it may be achieved by:

- introducing new or improved goods or services and/or

- implementing new or improved operational processes and/or

- implementing new or improved organizational/ managerial processes

Basically, innovating has to do with newness. To make something new is the most obvious definition of innovation. Nevertheless, we will see that innovation is a little bit more than making something new. You innovate to be different from your competitors and reach a wider audience of customers. Therefore, innovation is more an idea, a practice or an object that is perceived as new by a group of potential adopters (Rogers, 1965).

Innovation and competitiveness have a dynamic, mutual relationship. Innovation thrives in a competitive environment and in turn, plays a key role in the achievement of such an environment. Innovation generates economic value, new jobs in the economy and cultures of entrepreneurship. By virtue of its relationship with competitiveness, Innovation emerges as a factor in promoting economic growth.

1.2 MECHANISMS OF INNOVATION

There are different mechanisms to generate strategic advantages – how the products or services will be seen as different from the rest, when innovate. The main ones are presented in the following Table 1.

Table - 1

Mechanism	Strategic advantage	Examples
Novelty in product or service	Offering something no one else can.	The first car, the first mobile phone, the first disposable pen,
Novelty in process	Offering it in ways others cannot match – faster, lower cost, more customized, etc.	The courier service of Federal Express was totally new at the beginning and its efficiency could not be matched by any of the existing players.
Complexity	Offering something that others find it difficult to master	In the micro-electronics industry, some companies master unique processes which allow them to produce unique products. It could also be a complex process to make a specific dish for a restaurant
Legal protection of intellectual property	Offering something that others cannot do unless they get a license	Xerox in the 1960s managed to protect the main technologies on its copy machine and was the leader for many years as nobody could reach the same level of quality
Add/extend competitive factors	Move basis of competition, price to quality to choice	Canon, to beat Xerox, chose to focus on smaller copy machines, more affordable and without service needed. They moved the basis of competition.

Timing	When you are the first to introduce a product on a market	Most of the big players on Internet were the first ones to launch a specific service. Other Competitors arrived but the first ones remained the first in market shares.

1.3 TYPES OF INNOVATION

Mainly there are two types of innovation:

1. Incremental innovation
2. Radical innovation

The main differences between these two types of innovation are:

Table- 2

	Incremental	**Radical**
Emphasis	Cost or feature improvements in existing products, services or processes	Development of new businesses, products and/or processes that transform the economies of a business
Technology	Exploitation of existing technologies	Exploration of new technologies
Trajectory	Linear and continuous	Sporadic and discontinuous
Business case	Detailed plan can be developed at the beginning of the process	Business model and plan evolves through discovery-based learning
Idea generation & opportunity recognition	Occur at the front end; critical events are largely anticipated	Occur sporadically throughout the life cycle, often in response to discontinuities in the project trajectory

1.4 Disruptive innovation:

Disruptive innovation can be defined as follows:

1) A successfully exploited product, service or business model that significantly transforms the demands and needs of a mainstream market [value network] and disrupts its former key players
2) A technologically simple innovation in the form of a product, service, or business model that takes root in a tier of the market that is unattractive to the established leaders in the industry

A disruptive innovation is an innovation that generally starts as being less "interesting" or less performing than the current products or services in a market but ends up with a performance, after a few months or years, that it destroys completely an existing and often large market and its key players. Examples of disruptive innovations are digital photography (the different technologies behind it) that at the start was of a very poor quality compared with traditional photography but gradually replaced it and downloadable media that is gradually replacing CDs and DVDs.

Disruptive innovations do not occur often and are definitely less frequent than radical innovations that are themselves less frequent than incremental innovations. Nevertheless, it is important to know that it can happen. Overall, as small and medium enterprises (SMEs) are not the main originators of disruptive technologies, it is something to consider in your environment.

The creation of a competitive cluster in a region or a country is very important for the development of world-class innovative companies. Being established inside a cluster can provide lots of advantages to the company and support its future growth. Therefore, if a person creates a company or if he has the opportunity to relocate his activities, he should carefully study if there are any clusters in creation of industry in the country

1.5 SOURCES OF INNOVATION

Innovations can come from many sources. Recognizing these sources is important in the innovation process. The main sources of innovations are provided in the following sections.

- **Dedicated employees**

  The research and development (R&D) personnel are generally considered to be the main provider of innovations inside the company. As such, they have to be managed specifically and obviously integrated in new product development processes.

- **Other employees**

  Any employee in your company is a potential source of innovations. This has been recognized in many companies for a long time by the introduction of "ideas box" or innovation contests. Even if you are managing a company in a technology-intensive industry, where you genuinely think that the dedicated highly skilled personnel is the main source of innovations

- **Customers**

  Customers are one of the most important yet neglected sources of innovation. Customers are users of the products or services. As such, they are very well-positioned to give ideas on how to enhance the existing products (incremental innovation) or even to create entirely new products or services (radical innovation). Therefore, they should be regularly asked for feedbacks on existing products and for pre-tests of potential innovations before these are launched

- **Suppliers**

  Suppliers also have a good knowledge of the products or services or at least of parts of them. With the development of outsourcing, suppliers are more and more involved in the development of products and services. So, they are also obvious sources of innovations. Firstly, as they are often doing their own R&D on their own parts or products, company can directly benefit from innovations developed by them.

- **Public and private research labs**

  If company is in a technology-intensive industry, then research labs are one of the most important sources of innovation. Research labs all over the world are focusing more and more on applied research and the mission of the public ones is to enhance the competitiveness of local companies. So, they are very open to co-development or to the licensing of their technologies. Generally, they tend to prefer collaborating with large companies than with SMEs as it generates more revenues for them. Nevertheless, most of them are encouraged by governments to also work with SMEs

- **Competitors**

  It simply means that companies are cooperating more and more on some projects while competing on others. This is particularly true for projects that require a high financial investment or need a research and development level for which one single company does not have all the competences in-house

1.6 NATIONAL ENVIRONMENT FOR INNOVATION

The national environment for innovation is made of four different blocks of stakeholders who will interact to create a sustainable climate for innovation. These blocks of stakeholders are:

Factors conditions - The most important factor is the presence of high-quality human resources. Skilled and highly skilled personnel are needed to provide scientific and technical knowledge and also to manage the companies. The presence of a strong educational system is therefore very important, including world-class universities and colleges. Universities will also be the source for basic research. Basic research is the starting point of most innovations, particularly in high-tech industries. Development of knowledge in universities will lead to applied research that can be used by companies. Information infrastructure is the third main element of the factors conditions. Nowadays, it is obvious that the flows of information have to be absolutely fluid for the knowledge to circulate efficiently. With the development of internet, we can observe that in countries where internet is widely used a new economy has appeared around it.

Demand conditions - The nature of the local demand plays a very important role on the innovativeness of an industry. The local demand has to be understood as the customers and/or the final customers, depending on your activity. Customers could be a very strong source of innovation. The mechanism is very simple: if the local customers are very demanding, local companies in return will have to develop more and more sophisticated innovations to answer their needs. As a consequence, these innovations will provide a competitive advantage in other markets

Related and supporting industries - Having suppliers or related firms that are strong innovators will have a positive influence on the innovativeness of company and industry. Again, if these companies are themselves organized into competitive clusters, the benefit will be from the above-normal rate of innovations in the suppliers' industry

Context for firm strategy and rivalry - Two main drivers are in play. Firstly, if firm operate in a country or in a region that is supporting the investment in innovations, there will be an advantage as the benefit come from various stimulus packages to innovate. Secondly, if company operate in a highly competitive environment, the creation of a competitive cluster in a region or a country is very important for the development of world-class innovative companies. Being established inside a cluster can provide lots of advantages to the company and support its future growth. Therefore, if we create a company or if we have the opportunity to relocate our activities, we should carefully study if there are any clusters in creation in your industry in your country

1.7 PROCESS INNOVATION:

Process innovation means the implementation of a new or significantly improved production or delivery method (including significant changes in techniques, equipment and/or software). Minor changes or improvements, an increase in production or service capabilities through the addition of manufacturing or logistical systems which are very similar to those already in use, ceasing to use a process, simple capital replacement or extension, changes resulting purely from changes in factor prices, customization, regular seasonal and other cyclical changes, trading of new or significantly improved products are not considered innovations.

Process innovation examples:

Precision Ring Makers (PRM) made components to high specifications, largely for the aircraft industry. Its main development work was focused upon process improvements. It had developed low cost tooling techniques which resulted in great savings: for example, tooling changes for thin guage shims using conventional techniques cost about £4000, while with PRM's technique the cost was about £30. It had purchased CNC machines for milling and engraving, and was planning to network the CNC machines to its computer system so that programmes could be transmitted directly to production.

Fabrication and Assembly Company (FAC) was primarily interested in welding technology. A recent example of process improvement was the application of plasma cutting instead of drilling, in the manufacture of heat exchangers and plates. A flushing system to prevent the build-up of sludge in the air chambers of the water tables which were being manufactured, was also developed to assist the introduction of plasma cutting

1.8 DYNAMICS AND DIFFUSION OF INNOVATIONS

In this section, there are two very important concepts. Firstly, how innovations evolve with time and how you will need to adapt the activities in the company, depending on the stage of development. Secondly, how an innovation is diffused inside an environment, how it is adopted by the potential users. Understanding these two concepts has very practical implications on how you develop and manage innovations in your company

A. The dynamics of innovation

The dynamics of innovation show how the rate of major product and process innovations are evolving over time for a specific technology

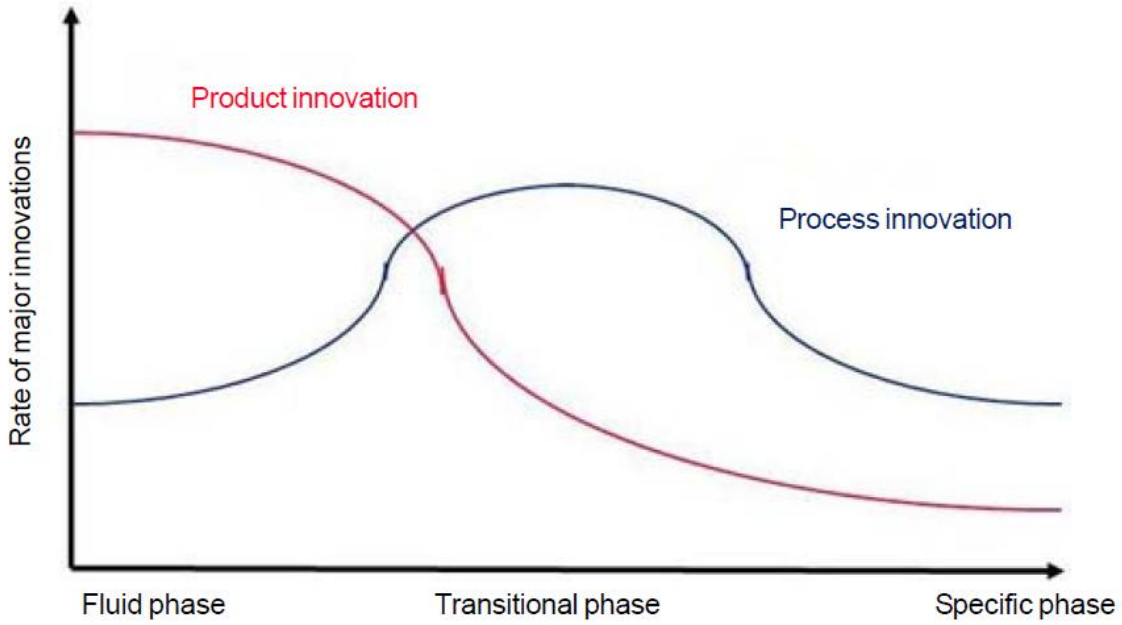

Figure 1: Product and process innovations

(James M. Utterback and William J. Abernathy, 1975. A Dynamic Model of Product and Process Innovation," Omega, vol. 3, No. 6, pp. 639-65)

Table – 3(Dynamics of Innovation)

	Fluid phase	**Transitional phase**	**Specific phase**
Innovation	Frequent major product Changes	Major process changes required by rising demand	Incremental for product with cumulative improvements in productivity and quality
Source of innovation	Industry pioneers, product users	Manufacturers, users	Often suppliers
Products	Diverse designs, often Customized	At least one product design, stable enough to have significant production volume	Mostly undifferentiated, standard products
Production processes	Flexible and inefficient,	Becoming more rigid with changes	Efficient, capital intensive and rigid;

	major changes easily accommodated	occurring in major step	cost of change high
R&D	Focus unspecified because of high degree of technical uncertainty	Focus on specific product features once dominant design emerges	Focus on incremental product technologies; emphasis on process technology

(Joe Tidd, John Bessant and Keith Pavitt, 2001. Managing Innovation (Chichester, United Kingdom: John Wiley & Sons)

Basically the rate of product innovation will be very high at the start and the rate of process innovation will be low. Gradually, the rate of product innovation will diminish as a dominant design appears. A dominant design is a set of attributes for a product or service that becomes the best accepted by customers. It becomes the mainstream characteristics for a type of product. For example, it could be the technology used for televisions (LCD versus plasma), the power of the speakers, the number and types of connections on your television (TV) (number of HDMI, USB plugs)

Once the dominant design appears (the personal computer [PC], for example, in the computer industry in the 1980s), the innovations will shift from product to process innovations. As the type of product to offer is known, there is no need to invest into the development on new products; companies have to focus on the features like quality, cost. This is achieved through process innovations. Once the products are fully standardized, the general rate of innovation (both product and process) will drop until a new technology emerges (technological breakthrough or disruptive innovation).

Technological progress will thus evolve from one technology to another with regular technological breakthrough (see in Figure 2)

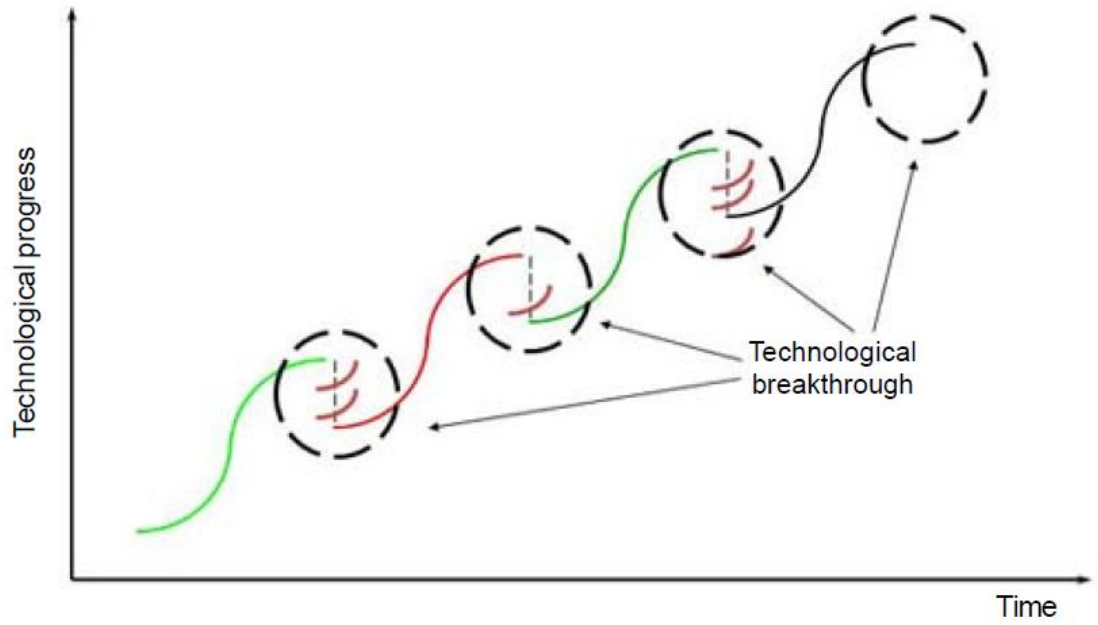

Figure 2: Continuities and discontinuities in technological progress

(F. Olleros, 1986. Emerging Industries and the Burnout of Pioneers. Journal of Product Innovation Management, No. 1, pp. 5–18)

B. The diffusion of innovation

"If a train speed is more than 180 km/h, passengers will suffocate"
— D. Lardner, Professor at the University of London, 1850

"There is a low probability that we will one day master the atomic energy"
— Robert Millikan, Nobel Prize in Physics, 1923

How an innovation is diffused, whether or not it will diffuse has always been a very important question. Obviously if the company innovate, It may be sure by the company that there innovation is adopted by many potential adopters as possible.

Path of diffusion: For the majority of innovations, the diffusion will follow the same path presented schematically in the Figure 3

The adopters are differentiated according to their speed of adoption. The first adopters are named innovators, followed by opinion leaders, more often named "early adopters". We then find the early majority. These three groups represent 50 per cent of the total number of adopters. The other 50 per cent are separated between the late majority and finally the laggards.

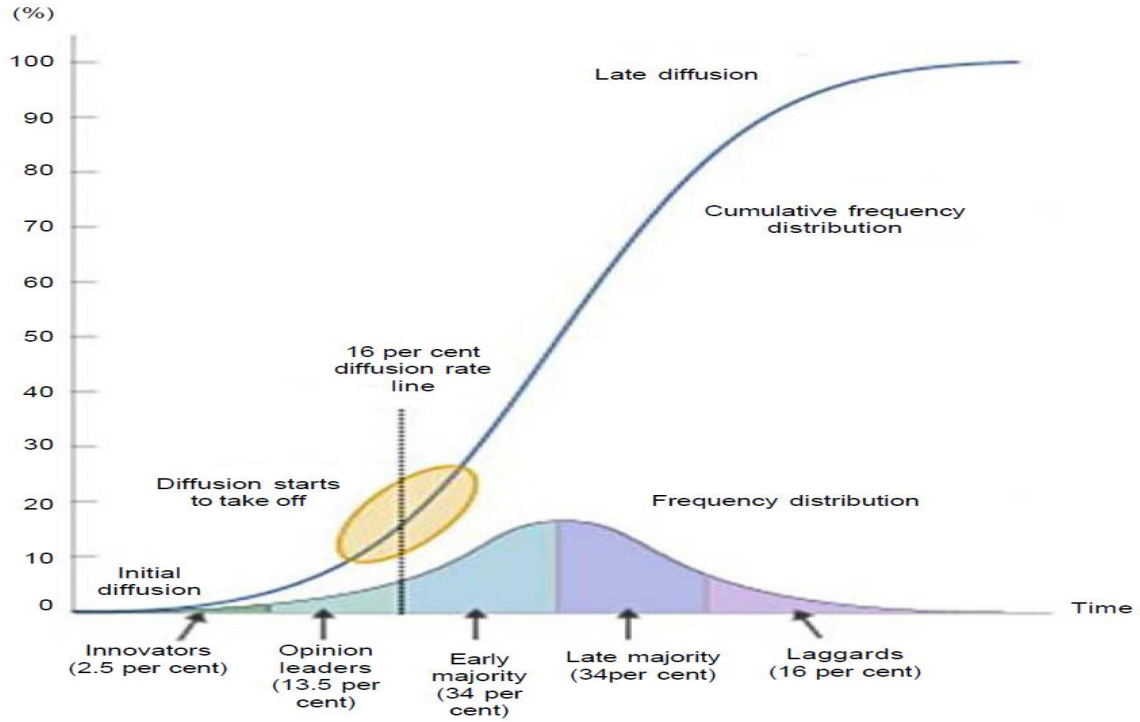

Figure 3: Curves of diffusion

(www.mitsue.co.jp/english/case/concept/img/02/fig1.gif.)

Criteria for the diffusion:

The first set of criteria is made of the perceived attributes of innovation. It is very important to notice that, as in marketing, we are working with potential customers who as human beings will have a perception of products or services. It implies that each and every potential adopter of an innovation will have a different perception.

The five perceived attributes of innovation are provided below:

1. Relative advantage

It's the degree to which an innovation is perceived as better than the idea/product/service it supersedes. It can be measured in economic terms, social-prestige factors, convenience, satisfaction; Relative advantages can be in terms of price, cost of usage, quality , associated services but also if the product or the service provides the image of a higher social status to the adopter.

2. Compatibility

It's the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of potential adopters. There are mainly two types of

compatibility studied. The first one relates to the technical compatibility of your product The second type of compatibility is more subtle; it deals with the moral values of the potential adopters.

3. Complexity

It's the degree to which an innovation is perceived as difficult to understand and use This is a very simple factor to understand, yet is not always taken carefully into account. A new product or service, targeted at professionals or end-users, for example, should be easy to implement and easy to operate

4. Trialability

It's the degree to which an innovation may be experimented with on a limited basis. The possibility to "try before you buy" is a very important factor in the adoption decision process. Obvious examples are cars or shoes (which you would not buy without trying them). This factor is widely used in the software industry where lots of companies would offer software for a period of 15-90 days and then ask you to buy it if you still want to use it.

5. Observability

It's the degree to which the results of an innovation are visible to others.

If a customer can observe the results of the implementation of a product or service, they will be more inclined to buy it. For example, if you sell a fertilizer or a weed killer, actually showing potential customers that it really works is beneficial. Any kind of proof of the effective results of the implementation is positive

The second set of criteria deals with the type of decisions taken to adopt or reject an innovation.

There are three main types.

1. **Optional innovation – Decisions**

It is when the choices to adopt or reject an innovation are made by an individual independent of the decisions of others. This is the most common situation for end-users/consumers products or services. In this case, it means that you have to convince each individual or company to buy your innovation.

2. **Collective innovation – Decisions**

This situation is when choices are made by consensus among the potential adopters. This is mostly when groups of companies or groups of individuals will make a choice together. For example, groups of companies in a specific industry could decide to adopt a specific standard. This is the case, for example, in the telecommunication industry or in the banking industry. In this case, it means that you have to convince an entire group and not individual's one by one but that when the choice is made, the innovation will be as a consequence automatically adopted by all the members.

3. **Authority innovation – Decisions**

This last situation is when choices are made by a relatively few individuals in a system who possess power, status or technical expertise. The decisions taken by governments mostly will fall under this category. There are many examples of standardization decisions taken by governments

1.9 ALLIANCES FOR INNOVATION

As the technologies and the markets are more and more complex, developing innovations, producing them and selling them requires more and more skills, time and financial resources. As a small business, it is definitely very difficult now to launch a breakthrough innovative product or service alone. It means that there will be certainly have to set up alliances with research labs, suppliers, customers or even competitors for the development, product and/or commercialization of your products.

Different types of collaborative agreements are described below:

- **Strategic alliances:**

  It is a true alliance. In that case there is an agreement with one or several other partners to share or combine resources for a common aim. An alliance implies generally the signing of a contract that will detail what activities the different parties will have to perform.

- **Joint ventures:**

  An alliance can also take the form of an equity investment. It is a longer and stronger commitment. In that case, a joint venture will be created with one or

several partners to put together resources (including financial ones to create the joint company) to reach a certain goal.

- **Collaborative research:**
  This third case is when company will pool together resources (financial and/or people) with other companies or public research organizations for the specific aim of performing research activities

- **Licensing:**
  This is not strictly an alliance. A licensing agreement is when company would give the right to use a technology or a patent to another company and receive for a license fee for that (licensing-out). It is also the case when company buys the rights from another company or an organization

2.0 INNOVATION IN FIRMS

Innovation in firms is generally determined through Innovation Intensity**.** Innovation Intensity' is used to measure the prevalence of Innovation in a firm – where Innovation Intensity is defined to be "the percentage of revenue derived from products/ services which are less than 3 years old".

Based on a report submitted by the National Knowledge Commission in India (NKC, 2007), SMEs have greater Innovation Intensity than large firms. Some other glaring issues that were reported were:

- Innovation Intensity for privately and publicly owned firms is significantly higher than that of government owned firms.

- Firms with majority foreign ownership have greater Innovation Intensity than those with majority Indian ownership.

- Innovation Intensity for MNCs is significantly higher than for non-MNCs while there is little difference in the percentage of 'Highly Innovative' firms among MNCs and non-MNCs.

- Internal processes for Innovation such as maintaining a specific Innovation department, allocating funds, rewarding innovative employees, forecasting probabilities of success, formalizing processes and systematic attempts, maintaining physical locations for Innovation and constituting cross functional teams all lead to firms being more innovative. Further, firms with greater R&D spending, Innovation spending and strategic prioritization for Innovation are also more likely to be more innovative.

- Firms with their primary market in India have higher Innovation Intensity than those with primary markets abroad. On the other hand, a greater proportion of firms with their primary market abroad are Highly Innovative (i.e. have introduced more 'new to world' Innovations) as compared with firms with their primary market in India.

- Firms in industries where Innovations are patented, with more patent filings and use of IPR consultants are more innovative.

- Firms partnering with government agencies, collaborating with universities and R&D labs also tend to be more innovative.

2.1 MARKETING INNOVATION

The marketing of product or service start once it is fully ready, it is important to start thinking about the marketing at the beginning. How the market can influence the features of the product and it is advised to modify the characteristics of a product or service before the production has started

Perceptions:

The first step in the definition of the marketing strategy is to find out how the product is perceived by potential adopters. Remember that the degree of innovativeness of a product is a question of perception. And it is obviously important that our perception is the same as the perception of the potential customers. If our product is a radical innovation and the customers think that it is "only" an incremental innovation, then they will be disappointed by its performance. On the contrary, if our product is an incremental innovation and the

customers perceive it as being radical, they will certainly not understand it correctly, not understand your communication and not adopt it

Information on the market:

If the product is a radical innovation, there will certainly be in a situation of supply side marketing (which is when a product creates a market). This is a very risky approach of course as if the market is new; it means that you don't know anything about it and that there are no prior studies on it, nor any database or statistics that we have so there will great risk. In order to overcome the risk companies have to think in terms of frontier markets. A new product or service, even if it is a disruptive innovation, is always either superseding or complementing an existing product or service. Cars replaced horses and horse carriages; telephone replaced telegraph and mail etc. Secondly, company have to find market pioneers or lead users lead users or market pioneers will be the first ones to recognize a need for the product or service, its first users and the ones telling what's right or wrong with it

Pricing:

It is very hard to determine a price for a totally new product in a totally new market. Frontier markets were able to get information on the pricing of the products that our innovation aims at replacing or complementing. If the product or service is complementing an existing product, the price will have to be near or below the price of this product.

Distribution:

- Marketing the product directly to the customer.
- Marketing through agents, distributors or resellers in each geographical market.
- Marketing through one or a few major international distributors who will brand your products as their own and market it the

2.2 PROTECTION OF INNOVATIONS:

Protecting innovations is a very important decision. In most cases, it is highly recommended to get some form of legal protection. There cases where protection of your innovation is not obvious and should really be assessed:

If the pace of innovations is very high – In some industries (the personal computer industry or some parts of the software industry, for example) the pace of innovations is so high that by the time company would have patented there product it would be obsolete, replaced by there innovations or by the ones of competitors.

If you are operating in an industry where main innovations are disclosed in research documents or conferences – In industries where biotechnologies or nanotechnologies are used, some radical innovations are coming from researchers working in public labs who may sometimes disclose their innovations in conferences or research journals

If the process of protection would imply revealing part of the innovation. By essence, to patent an innovation, company has to describe it in details and provide drawings or illustrations. Even if these details or illustrations will be available to third parties only when the patent is granted, so theoretically protecting the company, it can nevertheless provide elements to competitors to go around the patent and develop their own product using another process, for example, or any other way that will not be considered as counterfeiting

There are three main types of protections: patents, trademarks and copyrights.

A. Patents

According to the World Intellectual Property Organization (WIPO), the United Nations agency in charge of intellectual property, a patent is an exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem.

The general rule for an invention to be patentable is that it must present some novelty compared with the existing products and must be of practical use. What is patentable or not will depend from one country to another; but in general, methods, plants, animals and software are not patentable (for the later, there is a large variety of situations depending on the countries).

The right on the patent is generally granted for a certain period of time, most of the time for 20 years.

B. Trademarks

A trademark is defined as a distinctive sign which identifies certain goods or services as those produced or provided by a specific person or enterprise. A trademark gives the rights to the owner of a mark to use it to name its products or services or to sell the rights to use the mark and protects the company against the use by unauthorized parties. Contrary to patents, trademarks rights can be renewed indefinitely. Contrary to patents also, there is an international agreement, managed by WIPO, to register a trademark once for the 84 countries which signed the agreement known as the Madrid agreement

C. Copyrights

Copyrights are legal instruments protecting the right of creators on their work (WIPO). The creators can block or authorize the reproduction, translation, broadcasting, public performance or any other usage of an original work. Strictly speaking, the copyright exists as soon as the work is created. Nevertheless, in many countries, there are public agencies in charge of officially registering copyrights.

As protecting your innovations is not an easy process and as there are many differences between countries, it is strongly advised to do it with external help. If you can dedicate a budget for it, hiring a patent attorney (one for each country most of the time) is a good idea. You should at least seek help from your patenting/IP government agency

CHAPTER-2

LITERATURE SURVEY

Rodney McAdam et al. (2004) studied how innovation was successfully incorporated or hindered in SMEs within an EU peripheral region. An innovation model was applied in a multiple case study methodology involving 41 SMEs. Both quantitative and qualitative data were gathered and analyzed. The paper concluded that SMEs must strategically plan for innovation and move beyond continuous improvement, or "kaizen", and stated that such plans must avoid quick fixes and address the underlying cultural barriers to innovation, such as organizational structure, owner-manager leadership issues, a lack of empowerment and lack of use of employees' ideas and suggestions for innovation

Adegoke Oke et al. (2007) studied the types of innovation that are predominant in UK SMEs, whether they were predominantly radical or incremental, and to investigate the impact of these innovations on performance A web-based survey instrument was used to administer survey questionnaires to a sample of UK SMEs in manufacturing, engineering, electronics, information technology and telecommunications industries It is found that the SMEs tended to focus more on incremental than radical innovations and that this focus was related to growth in sales turnover growth

William Keogh et al. (2007) studied the longitudinal effect of innovation programmes on improving the process of innovation in manufacturing SMEs. The process of innovation in organisations coverd people, process and technology. Therefore interventions in the form of innovation improvement programmes often required high levels of complexity. This complexity was compounded in SMEs, where issues such as scarce resources and skill shortages were to recognized A multiple case research methodology combined with an innovation evaluation model was used to evaluate the longitudinal effect of an innovation intervention programme,

The findings revealed that SMEs, which had high levels of innovation improvement, adopted a broad process based approach to innovation rather than using a narrow technical definition of innovation. These SMEs also developed a process of critically reflective action learning to ground the innovation in organisational practice

Daiva Radzevicˇiene(2008)˙ analyzed the role of knowledge management (KM) in small and medium-sized enterprises (SMEs) in Lithuania by looking at information and knowledge resources, the development of information technology (IT) which supported the business process and the main processes of KM inside companies Questionnaires and some interviews within Lithuanian SMEs helped revealed what the present situation was in terms of KM processes and the use of IT There appeared to be a strong awareness of KM already. However, the development of adequate methods to make information management (IM) and KM fully effective appears to be lacking or only partially realized. There was some evidence to suggest that Lithuanian SME managers were becoming more psychologically prepared to work within KM but there was much less evidence to show that this was leading to effective innovation in practice at present

María Jesús Nieto et al.(2008) studied of critical success factors in the innovation process of low- and medium technology (LMT) industries. To accomplish this, the study explored how the innovation process in LMT firms may depend on non-formal R&D activities and the use of external sources. The empirical analysis was based on a representative panel of Spanish manufacturing firms. The results strongly support the view that nonR&D activities such as design, the use of advanced machinery and training are crucial to understanding the innovation process of any firm. The study found, that the impact of these activities was especially important in LMT industries, particularly for the achievement of product innovations. The empirical evidence also revealed the importance of external sources such as the use of consultants, the hiring of personnel, collaboration agreements and external R&D, with the greatest differences between LMT and high-technology (HT) firms being observed in process innovations

Dilek Cetindamar (2008) aimed to shed light on the relationship between partnerships and innovation efforts of the firms. The goal was to understand whether Turkish firms collaborate for innovation or not and, if they do, what was the impact of partnerships on the innovation performance of firms? The questionnaire was implemented through structured interviews conducted with 135 Turkish companies from the textile, chemical, food and machinery industries. The findings showed that Turkish firms had high-collaboration ties with other companies in particular but the existing partnerships had a weak impact on innovation performance .Turkish firms needed to find ways to improve their partnerships and in-house capabilities, particularly their absorptive capacities. The

studied investigated the relationship between technology collaborations and innovation performance of firms in a developing country context.

Elise Ramstad (2008) presented a developmental evaluation framework for innovation and learning networks. The study assumed networks with several actors based on an expanded triple helix model (workplaces, R&D infrastructure, and policy makers) and several learning processes enable better innovation potential and broader outcomes. Criteria for an evaluation framework were created, which were then contested with empiria, in this case learning network projects (n ¼ 17) funded by the Finnish Workplace Development Program me. The results showed that the created evaluation framework offers a useful tool to point out the networks with a best potential to broader outcomes for diverse actors. It could provide a tool for policy makers, but also for involving participants, in order to direct and coordinate innovation and generative learning more effectively. The study suggested that a common and strict pattern for an innovation and learning network, as one of their main goals was to create and experiment with new forms of development cooperation.

Angel Martı´nez-Sa´nchez, et al. (2008) aimed to analyze the relationship between labor flexibility and innovation performance. A postal survey of a sample of Spanish manufacturing and service firms was conducted. High-innovative Spanish firms were more flexible than low-innovative firms although the comparison across industries and type of innovation indicated that not all flexibility dimensions are statistically significant in their relationship to innovation performance. The practical implications give differences of flexibility dimensions found across industries and type of innovation firms should use flexibility capabilities to complement innovation capabilities.

Carmen Otero-Neira et al. (2008) exerted to understand the conditions that make innovation profitable. The methodology used in the analysis was a multi-case comparative research of low-tech, small and medium-sized furniture firms from Italy, Spain and Finland. The study showed some evidence that innovation positively influences business performance. In particular, the results suggested that different performance levels were linked to the type of innovation developed. It helped in direct implications for companies aiming at improving their innovation effectiveness. The study recommended that firms should consider the environment in which they operate; second, they should coordinate future innovation plans by considering the synergistic process

among the product, market and process innovations to arrive at a combination that will yield optimal levels of performance. Additionally, the study pointed out the crucial role that the management style plays in developing innovation capabilities. The studied offered an insight to explain why some companies are more successful at starting and developing innovation than others. The finding that a successful innovation profile was related to the performance of the company represented an interesting contribution to the management of firms.

Lucy Lu (2008) attempted to address the strategic challenges of developing knowledge-based innovation (KBI) in China through the analysis of the triple helix (TH) innovation networks between university, government and industry in China. In so doing, the TH model was adopted as an analytical framework to investigate the format and operations of knowledge networks within university, government and industry during the economic transitions in China. The study incorporated field observation, interviews with senior government officials, desk research on various government policy document as well as critical review of the existing literature related to KBI and the TH model in order to build up the strategic overview of the current state of KBI in China. It was identified that the formation and operation of knowledge production system in China on the one hand reflects the three dimensions within TH model: normative control (government), wealth generation (industry) and novelty production (university and public research institutions), on the other hand highlighted dynamic institutional interactions and transformational processes in creating the knowledge economy. The key factors that had an effect on the inter-institutional relations and evolutions of different knowledge functions within the TH innovation networks, had also been identified and manifested in the proposed theoretical framework of the knowledge production system in China.

Marius Lanskoronskis, et al.(2009) discussed the influence of university research management on institutional competitiveness, international visibility and fund-rising .The research findings were based on analysis of leading universities in six European countries. For the analysis, two criteria were chosen – institutional way of work and core partnerships. The findings suggesed that majority of leading universities in the analyzed countries actively realize principles of the Triple Helix and Mode 2 Science. This was realized through innovative managerial structures and strong orientation to practical implication of research production. The findings summarized the main forms of

institutional work and discuss core partnering issues. A limited number of universities were chosen and data was mainly collected from secondary sources such as institutional documents, web site information or corporate presentations. The findings served as a framework for considering changes in university research management structure or seeking increase of institutional competitiveness, international visibility and effective fund-raising.

Eric Quintane, et al. (2009) provided clarity to the concept of innovation and its various definitions. The study reviewed the innovation literature and proposed that innovation had been conceptualized either from a process or from an outcome perspective. Also, there was a substantive difference between innovation seen in the traditional innovation literature and innovation as conceived in the knowledge management literature. The study proposed a general framework to categorize the existing views of innovation and show that innovation as an outcome had not been clearly defined from a knowledge perspective. To address this gap, the study developed a new definition of an innovation outcome based on knowledge elements. The research laid the groundwork for more comprehensive methods of measuring innovation and innovativeness, which was particularly useful for the study of service innovation. The framework and definition expand the ability of managers to measure and understand the key factors of innovation.

Michele O'Dwyer et al. (2009) developed a theoretical framework to facilitate further exploration of the core elements of innovative marketing in SMEs A case study approach was adopted in order to facilitate the emergence of new theoretical relationships based on the understanding of the complex and dynamic nature of innovative marketing in SMEs. Eight case SMEs were recruited, two of the case SMEs from the service industry, three from manufacturing and three of the SMEs combined elements of both service and manufacturing The findings of the study illustrated the component parts of innovative marketing and the inter-relationships between those parts in accordance with their role in innovative marketing and practices in SMEs

Richard Li-Hua et al. (2010) reviewed the literature of strategic aspects of innovation and internationalization in higher education. The study aimed to develop a theoretical framework which demonstrated how various objectives of innovation and internationalization could be translated and achieved in a learning organization context. The paper explored the ideas and links between globalization and innovation/internationalization in higher education. The main concern of the paper was the implementation strategy of innovation and internationalization rather than the concepts and process of innovation and internationalization in higher education. This paper also discussed the implementation of innovation and internationalization and how to translate the overall institutional strategy into managed objectives. Organizational learning not only asserts and promotes organizational outcome and improved performance but also played a significant role in achieving innovation and internationalization. The study also identified a number of strategic elements which were crucial to the successful implementation strategy of innovation and internationalization .The paper developed a theoretical framework which enabled policy makers and decision makers to make appropriate arrangements in designing international development strategy. Furthermore, the paper addressed the appropriateness and effectiveness of knowledge transfer, individual and organizational learning during the implementation of the internationalization strategy.

Antonio Perianes-et al. (2010) aimed to deliver empirical results based on quantitative data to gain insight into the role of private enterprise as an indispensable actor in scientific development and innovation. The study analyzed 50 most active companies in terms of internationally visible scientific output. The findings provided insight into business involvement in the R&D system based on: research papers published; national, international and sect oral collaboration patterns; structural patterns; and the identification of the most prominent companies from a systematic comparison of their research results and their position in the resulting collaboration network.

Ru-Jen Lin (2010) studied the effects of market orientation, market knowledge and customer knowledge management on product innovation performance from the perspective of dynamic capability. The data were collected from high-tech firms in Taiwan. This study employed the Structural Equation Model (SEM) to examine the relationships between market orientation, market knowledge, customer knowledge management and product innovation performance. The study suggested market

orientation has no significant impact on product innovation performance, and market knowledge and customer knowledge management mediate the relationship between market orientation and product innovation performance. The paper implied that besides utilizing market orientation for innovative practices, the high-tech industry should focus more on market knowledge and customer knowledge management. In high-tech industries, the process of knowledge management, which transferred customer knowledge to product innovation, could effectively seize market information.

Jing Zhang (2010) examined the role of responsive market orientation and proactive market orientation in product innovation performance directly and indirectly via innovativeness, as well as the moderating effect of environmental turbulence in the market orientation-product innovation performance link among Chinese manufacturing firms. The research results showed that: both proactive market orientation and responsive market orientation have a positive total effect in improving product innovation performance; the direct path dominated the total effect of responsive MO on new product success, while proactive MO impacted product innovation performance primarily via innovativeness as a mediating variable; and the role of responsive market orientation in new product success was more significant under stable technological and market conditions, while proactive market orientation improved product innovation performance to a greater extent under turbulent technological and market conditions.

Miriam Delgado-Verde (2010) aimed to test empirically the relationships between organizational knowledge assets and the innovation capability of the firm. The data collection was carried out through a questionnaire on a sample of 251 Spanish high and medium-high manufacturing firms. Exploratory and confirmatory factor analyses and multiple linear regressions were also used. The work explored the nature and measurement of organizational capital as well as its role on innovation performance in high and medium-high manufacturing firms. The paper proposed a theoretical and empirical model of technological innovation that, based on organizational knowledge assets, highlighted the importance of culture and CEO commitment towards innovation, as well as the role played by communication and information technologies (CITs) applied to management on product innovation capability within high and medium-high manufacturing firms.

George Tsekouras (2010) analyzed the types and the nature of innovations developed by small companies in a traditional service sector, as well as the ways that innovations impacted their strategic capabilities. The paper provided evidence from three case studies captured through a number of interviews with senior managers within the companies. The paper adopted a comparative analysis, selecting two cases that had managed this process with great success. The study found that organizational and process innovations were critical aspects of a dynamic strategy in small service companies. Although a successful innovation strategy did not require the development of technological systems and knowledge intensive services, it did necessitate their sophisticated usage. Innovation enabled the firms to access new markets and the reconfiguration of strategic capabilities in the long term. The paper identified the existence of strong linkages between organizational and process innovation and dynamic capabilities in the small companies in a traditional service sector. This work called for managers in small companies in a traditional service sector which wish to grow to pay more attention to their active involvement in organizational and process innovations and the sophisticated usage (or development) of knowledge intensive services.

Sylvie Laforet (2010) examined innovation in small and medium-sized enterprises (SMEs), and developed a comprehensive theoretical framework of how innovation occurs, the end result, and impact on business financial performance, focusing on three types of innovations. The study used a grounded methodology. Interviews with entrepreneurs from across industries inform the development of the research propositions. Besides market environment, business and quality aspects, for SMEs innovation was driven by a desire to be successful, and improve working conditions. Positive outcomes of innovation included an enhancement of SMEs' reputation and image, an increase in operational efficiency and cost benefits, resulting in a better business financial performance, recruitment of a more skilled workforce, and greater in-house expertise leading to further innovation. The negative outcomes of innovation related to management, operational issues, and financial risks. The study contributes to the theoretical basis for understanding organizational innovation in SMEs. The proposed framework was focused and comprehensive, enabling a better understanding of innovation

Rajesh K. Singh et al. (2010) analyzed different challenges for small and medium enterprises (SMEs) in India and China following globalization. It aimed to describe the status of these enterprises and examined the roles of government policies and strategy development for competitiveness. A questionnaire-based survey was conducted, which produced 241 valid responses. Of these, 80 percent were from SMEs. Statistical analysis of the data acquired from survey used a reliability test, t-test and correlation analysis. A relevant literature review pinpointed salient issues in the environment of the SMEs. Various challenges for SMEs in these countries were similar; however, the rate of growth was different. Indian SMEs gave more attention to supplier development, total productive maintenance and the organization's culture. Chinese SMEs payed more attention to relationship management and cost reduction

Gregorio Martı´n-de Castro (2011) highlighted the importance of knowledge management and organizational learning in firm innovation, offering an integrative framework to understand the complex business phenomenon. Theoretical and empirical works were organized in three main topics. The first one refers to the importance of external knowledge, networking, and relationships as key drivers of firm technological innovation, offering an ''open or relational innovation framework''. The second one showed the growing importance of KIBS (Knowledge-Intensive Business Services) in a Knowledge Economy and Society. The study tried to offer some new relevant advances for the academic community in the growing body of knowledge management and firm innovation.

Ramzi Addison (2011) studied a Thai manufacturing small to medium-sized enterprise (SME) in order to develop a basic understanding of the innovation concept and process in Thailand, and to investigate how the five factors associated with innovation interact with Hofstede's five cultural dimensions to influence the innovation process. The studies of national culture and innovation potential use Hofstede's dimensions but study suggested that in Thailand there may be cultural factors other than Hofstede's that influence innovation and that modify the effects of Hofstede's model on innovation. The first finding from this study suggested that Thai SMEs tended to more effectively produce or adopt incremental innovations rather than radical ones. The second finding was that, if the research company is typical of Thai SMEs, Thai SMEs were likely to experience difficulties with adopting completely novel innovations effectively. This was because

four (except the dimension of long versus short-term orientation) of Hofstede's five Thai cultural dimensions were clearly found to obstruct the innovation process.

Sabine Hotho (2011) examined changing people management practices as the case company underwent industry-typical strategic change to embark on explorative innovation and it sought to argue that maintaining an organizational context conducive to innovation over time risks turning into a contest between management and employees, as both parties interpret organizational pressures from their different perspectives. Findings indicated that management and worker perspectives on innovation as strategic change and the central people management practices required to support this differ significantly, resulting in tensions and organizational strain. As the company moved to the production of IP work, the need for more effective duality management arose.

Mario Javier Donate (2011) Analyzed how organizational factors such as cultural values, leadership and human resource (HR) practices influenced knowledge exploration and exploitation practices and innovation via an empirical study. From the knowledge-based view of the firm, six hypotheses were established and statistically tested in a sample of 111 Spanish companies belonging to innovative industries. Survey methodology was used with the aim of gathering data regarding knowledge management (KM) practices and certain, related organizational aspects in firms. The study provided evidence of a moderating effect of knowledge-centered culture, knowledge-oriented leadership and knowledge-centered HR practices in the relationship between knowledge exploration and exploitation practices and innovation outcomes of companies. The results of the study suggested that managers should place attention on knowledge exploration and exploitation practices along with several organizational enablers in order to achieve high levels of innovation results for the company. The paper also provided new empirical evidence on the relationships between KM, organizational elements such as culture, leadership, HR practices, and innovation in a large sample of firms.

A. Banu Goktan (2011) examined the relationship between innovation speed, and radical product and process innovations. A survey of firms in the high-tech (semiconductor, audio video equipment and computer hardware) industries was conducted. Hypotheses were tested using a hierarchical multiple regression analysis. The results revealed a significant positive relationship between innovation speed and both radical product and radical process innovations. Radical product and process innovations

were highly correlated in the sample. Response rate was relatively low to the survey; however, control variables were included to ensure accuracy of results. The study empirically tested inter-innovation relationships within the high-tech industry. Findings suggest that firms should not avoid radical innovations with the fear of being late to market. In addition, based on these results, product and process innovations were closely linked to one another, and to innovation speed.

Michael J. Zhang (2011) explored the role of firm-specific information and knowledge that complement IS (information system) support for product innovation in moderating the performance impact of the IS support. Both survey and archival data were used to assess the profitability impact of IS support for product innovation. Data tapping IS support for product innovation and firm-specific, complementary information and knowledge were collected from a survey of senior IS executives from 760 large companies operating in different industries in the United States. Providing IS support for product innovation alone did not improve profitability as measured by return on sales and return on assets. Only when complemented by firm-specific information and knowledge would IS support for product innovation lead to profitability gains. It was not sufficient for a firm to simply focus on selecting or designing IS that improve the efficiency and effectiveness of its product development process. Rather, the firm and its managers needed to pay equal attention to the deployment of firm-specific information and knowledge resources which would not only facilitate the use and implementation of IS for production innovation, but also made such IS less susceptible to imitation by competitors. The study provided further evidence for the positive influence of IS-based product innovation on the bottom-line performance of firms and uses the resource-based view of the strategic impact of IS to identify one condition under which such influence might occur.

Mary Hardie (2011) determined whether any common lessons could be drawn from the experience of individuals who had gone against the trend and delivered successful technical innovations in construction small and medium enterprises (SMEs). A value tree of contributing factors to technical innovation was developed from the literature and tested by surveying established technical innovators using analytic hierarchy process methodology. This approach aimed at capturing the experience of company decision

makers who managed to deliver successful change with limited resources. The results revealed the importance of supportive clients and performance-based building standards for innovative practice in construction. Significant differences were observed between small and medium-sized companies and between product and process innovators. Industry employment rates and profitability were both positively correlated with high rates of innovation in many industries. The paper provided suggestions for managers of construction firms who wished to improve innovation performance rates by studying the insights of successful innovators in their field.

Xiao-Ping Lei et al. (2011) analyzed the Chinese patent data retrieved from the United States Patent and Trademark Office. The study used patent data which had been treated as the most important output indicators of technology change and innovative activities, with the help of patent analysis conclusion of study, explored Chinese inventive activities and technology collaboration patterns of UIG in the prospect of providing a reference for the directions of future policy and academic researches. Three innovation characteristics of UIG in China can be featured: First, FEs were the strongest innovation unit in China, and these enterprises were most from Taiwan and Hong Kong. Ignoring the innovative capacities from these two regions would leave FEs occupy only a few percentage of inventive outputs. Second, collaborations between industry and university grow rapidly. The trend helped to promote a positive innovation system. Last but not least, the Chinese UIG relations were close to Triple Helix III, though the collaborations of UIG still needed to be encouraged and strengthened in the future.

Elodie Gardet et al. (2012) identified and characterized the coordination systems used by SME hub firms that were in a situation of dependence with respect to other members of their network, taking into account the influence of hub firm size Seven case studies were carried out: six innovation networks in which SMEs play a central role are compared with a "reference" case, in which the hub firm was a large company. The qualitative empirical analysis conducted in the study of seven innovation projects showed that: the sharing of benefits and the guarantees that were implemented vary depending on the hub firm's degree of dependence; trust and recourse to formal agreements differ according to hub firm size; and conflict solving was influenced by both hub firm size and degree of dependence

Zhang Bo et al.(2012) studied technology innovation models from multiple perspectives such as growth stage of SMEs, the environmental features in the enterprises' locations, competitive characteristics of the industries and the enterprises' innovation ability. The research topic was designed to study the SMEs' innovation ability and characteristics in the different stages of development and in different industrial and development environments. On this basis, this paper put forward a dynamic multi-dimensional technology innovation model, combines SMEs' innovation practice to continuously improve their technology innovation model and established the innovation system, thereby enhancing the innovative capabilities. Through data analysis and research, the study researched the SMEs' technological innovation factors, and found the development law of technological innovation; various different modes of SMEs' technological innovation were analyzed from multiple perspectives to construct a multi-dimensional dynamic model of technological innovation.

CHAPTER-3

PROBLEM FORMULATION

3.1 GAP IN LITERATURE

From the literature survey, a lot of research has been carried out to examine the impact of process innovation on industry growth. Research in developed nations also reveals the role of private enterprise which acts as an indispensable actor in scientific development of process innovation. Also some work has been done in studying the role of manufacturing technology and external knowledge in process innovation performance. Research in European countries has also been conducted to determinants of process innovation in SMEs. Most of the research done has taken a combination of a large number of factors contributing to process innovation as input variables and used the input from these in ascertaining their impact on process innovation. Also, these factors have been considered for different industry segments and sizes. Few such studies have been done on SMEs and with different combination of factors

3.2 OBJECTIVE OF THE STUDY

Analysis of determinants of process innovation in small and medium enterprise (SMEs) in Cutting Tool Industries.

3.3 RESEARCH METHODOLOGY:

Variables and measures:

3.3.1 Dependent variables:

The dependent variables are relative to firm innovation performance in a specific period t. In order to capture the different innovation outputs, along with the distinct levels of complexity, two separate measures were used: product innovation, process innovation but our study is focused on process innovation

Process innovation was assumed to have happened when the firm indicated it had introduced some significant modification in the production process. This modification may involve the introduction of new machines or new methods of

organization, or the introduction of both. Process innovation is also a dichotomous variable innovation but in the study of process innovation we use likert scale mostly

3.3.2 Independent variables

The first objective is to understand the role of other innovation activities beyond formal R&D in SMEs industries. To do this, a wide selection of potential inputs to firms' innovation processes was considered. Thus, along with the decision to perform formal R&D (internal and/or external), use of advanced manufacturing technology, training and external knowledge were included. The decisions to perform and/or contract the innovation activities were measured mostly by likert scale. Apart from formal measure of R&D the database includes qualitative data on other innovation activities. Following innovation activities are mainly use to measure:

1. Company R&D
    - Management support
    - Funds
    - Technical expertise
    - Infrastructure
    - Range of involvement
    - Government support
2. Acquiring of external knowledge
    - Funds availability
    - Adaptability
    - Staff competence level
    - Academic assistance
    - Industry assistance
3. Acquisition of new machinery technology
    - Funds
    - Outdated technology
    - Source capability

- Adaptability
- Government funding
- Tax concession

4. Training
    - Personnel selection
    - Process selection criteria

To collect information regarding the above mentioned aspects, the following steps will be carried out:

- Design of Questionnaire
- Assessing Questionnaire reliability and validity
- Pre Testing of the Questionnaire
- Data Collection
- Analysis of responses
- Results & discussion

3.4 Sample and Data:

The questionnaires were filled from 26 manufacturing company of cutting tools in the industrial area of Patiala city in the Punjab state. The questionnaire was filled by meeting the top management personally regarding process innovation industries. The respondent's data was further used for analysis work. Manufacturing company of cutting tools are mostly in Patiala city of Punjab state so sample or data collection was done in this region.

Chapter 4

ANALYSIS AND FINDINGS:

Since the questionnaire responses from the SMEs related to region, the results generated give us only indicative values, and this exercise can be treated as a pilot study and the results generated from the study be treated as indicators and preliminary. To analysis the questionnaire response from 26 cutting tool manufacturing SPSS (Statistical Package for the Social Sciences) software is used. The independent variables taken for study of process innovation are given below. While each independent variable have some factors.

- Company R&D
- Acquiring external knowledge
- Acquisition of machinery
- Training

The value addition to process which further consist of the following variable are as follow:

- Cost reduction
- Improved product capacity
- Reduced production time
- Increased manpower utilization
- Increased flexibility
- Quality improvement

The reliability analysis for internal consistency of the questionnaire was done by using Cronbach's Alpha value whose overall value is 0.815 (independent variable and dependent variable)

The correlation of each independent variable is discussed below:

1. Company R&D: Company R&D include following factors:

1. Management support
2. Funds
3. Technical expertise

4. Infrastructure
5. Range of involvement
6. Government support

The above mentioned factors of Company R&D correlate with value addition of process innovation in SPSS software in Table 4

Table 4Correlations

		mgt support	funds	technical expertise	infrastructure	range of involvement	government support	value addition (proccess)
mgt support	Pearson Correlation	1	.517**	.012	.384	.136	.140	.549**
	Sig. (2-tailed)		.007	.952	.053	.508	.495	.004
	T	-	2.95	0.058	2.03	0.67	0.69	3.21
Funds	Pearson Correlation	.517**	1	.015	-.042	.022	.171	.149
	Sig. (2-tailed)	.007		.942	.840	.915	.404	.468
	T	2.95	-	0.073	-0.20	0.107	0.85	0.73
technical expertise	Pearson Correlation	.012	.015	1	.294	-.086	.333	.438*
	Sig. (2-tailed)	.952	.942		.144	.677	.096	.025
	T	0.058	0.073	-	1.5	-0.4	1.73	2.3
Infrastructure	Pearson Correlation	.384	-.042	.294	1	-.016	.157	.672**
	Sig. (2-tailed)	.053	.840	.144		.937	.444	.000
	T	2.03	-0.20	1.5	-	-0.07	0.77	4.44
range of involvement	Pearson Correlation	.136	.022	-.086	-.016	1	-.255	.116
	Sig. (2-tailed)	.508	.915	.677	.937		.209	.573
	T	0.67	0.107	-0.422	-0.07	-	-1.29	0.572
government support	Pearson Correlation	.140	.171	.333	.157	-.255	1	.062
	Sig. (2-tailed)	.495	.404	.096	.444	.209		.763
	T	0.69	0.85	1.73	0.778	-1.29	-	0.304
value addition (proccess)	Pearson Correlation	.549**	.149	.438*	.672**	.116	.062	1
	Sig. (2-tailed)	.004	.468	.025	.000	.573	.763	
	T	3.21	0.73	2.38	4.44	0.57	0.3	-

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

From the correlation Table 4 it is examined that factor such as management support, technical expertise, infrastructure significantly contributing the process innovation. While the other factor are not up to the mark for contributing the process innovation.Infrastructure has highest correlation value of 0.672(r), $p < 0.01$, $t=4.44$

It can be observed from the Table 4 that the following factors have a higher correlation value and hence are more significant:

Independent Variable	Pearson Correlation values
Management Support	0.549
Infrastructure	0.672
Technical Expertise	0.438

Also that government support, funds and range of involvement have a lesser significance in value addition for process innovation

2. Acquiring external knowledge:

The second variable considered for process innovation is acquiring the external knowledge. This variable contain following factors:

- Funds availability
- Adaptability
- Staff competence level
- Academia assistance
- Industry assistance

Results from the correlation Table5 indicate that adaptability and staff competence are significantly contributing the process innovation in which staff competence level have highest correlations of 0.562(r) .$p < 0.01$,$t=3.32$

Table 5Correlations

		funds availability	adaptability	staff competence level	academia assistance	industry assistance	value addition (process)
funds availability	Pearson Correlation	1	.189	.274	.155	-.097	.058
	Sig. (2-tailed)		.355	.175	.451	.637	.780
	T	-	0.94	1.39	0.76	-0.47	0.24
Adaptability	Pearson Correlation	.189	1	.349	-.202	.018	.537**
	Sig. (2-tailed)	.355		.081	.322	.929	.005
	T	0.9	-	1.8	-1.01	0.08	3.11
staff competence level	Pearson Correlation	.274	.349	1	-.131	.090	.562**
	Sig. (2-tailed)	.175	.081		.522	.661	.003
	T	1.39	1.8	-	-0.64	.44	3.32
academia assistance	Pearson Correlation	.155	-.202	-.131	1	-.666**	-.182
	Sig. (2-tailed)	.451	.322	.522		.000	.373
	t	.76	-1.01	-0.64	-	-4.3	-0.90
industry assistance	Pearson Correlation	-.097	.018	.090	-.666**	1	.209
	Sig. (2-tailed)	.637	.929	.661	.000		.306
	t	-0.47	0.08	0.44	-4.37	-	1.04
value addition (process)	Pearson Correlation	.058	.537**	.562**	-.182	.209	1
	Sig. (2-tailed)	.780	.005	.003	.373	.306	
	t	0.24	3.11	3.32	-0.9	1.04	-

**. Correlation is significant at the 0.01 level (2-tailed).

It can be observed from the table that the following factors have a higher correlation value and hence are more significant:

Independent Variable	Pearson Correlation values
Adaptability	0.537
Staff competence level	0.562

Also that funds availability, academic assistance and industrial assistance have a lesser significance in value addition for process innovation

3. Acquisition of new machinery technology

The third variable considered for process innovation is acquisition of new machinery. The variable has following factors:

- Funds
- Outdated technology
- Source capability
- Adaptability
- Government funding
- Tax concessions

Results from the correlation Table6 indicates that funds, source capability, adaptability are significant contributing the process innovation in the industries while source capability have highest correlation of 0.651(r), $p<0.01$, $t=4.14$

Table 6 Correlations

		Funds	outdated technology	source capability	adaptability	government funding	tax concession	value addition (process)
Funds	Pearson Correlation	1	.231	.249	.573**	-.020	.092	.600**
	Sig. (2-tailed)		.256	.220	.002	.923	.654	.001
	t	-	1.1	1.2	3.4	-0.09	0.45	3.6
outdated technology	Pearson Correlation	.231	1	-.417*	.056	.133	.064	-.146
	Sig. (2-tailed)	.256		.034	.787	.517	.757	.475
	t	1.16	-	-2.2	0.27	0.65	0.31	-0.72
source capability	Pearson Correlation	.249	-.417*	1	.292	-.009	-.102	.651**
	Sig. (2-tailed)	.220	.034		.147	.967	.619	.000
	t	1.25	-2.24	-	1.49	-0.04	-0.5	4.2
Adaptability	Pearson Correlation	.573**	.056	.292	1	.036	.157	.646**

	Sig. (2-tailed)	.002	.787	.147		.862	.445	.000
	t	3.4	0.27	1.49	-	0.176	0.778	4.14
government funding	Pearson Correlation	-.020	.133	-.009	.036	1	.055	.000
	Sig. (2-tailed)	.923	.517	.967	.862		.790	1.000
	t	-0.09	0.65	-0.44	0.176	-	0.26	0
tax concessions	Pearson Correlation	.092	.064	-.102	.157	.055	1	.044
	Sig. (2-tailed)	.654	.757	.619	.445	.790		.833
	t	0.45	0.314	-0.50	0.77	0.26	-	0.21
value addition (process)	Pearson Correlation	.600**	-.146	.651**	.646**	.000	.044	1
	Sig. (2-tailed)	.001	.475	.000	.000	1.000	.833	
	t	3.6	-0.72	4.2	4.14	0	0.2	-

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

It can be observed from the table that the following factors have a higher correlation value and hence are more significant:

Independent Variable	Pearson Correlation values
Adaptability	0.646
Source capability	0.651
Funds	0.600

Also that government funding, tax concessions, outdated technology have a lesser significance in value addition for process innovation

4. Training:

The third variable considered for the process innovation is training. The variables have following factors.

- Personnel selection
- Process selection criteria

Result from the correlation Table7 indicate thatboth process selection criteria and personnel selection significantly contributing the process innovation in which personnel selection have highest correlation of 0.491(r) ,P<0.05 t =2.79

Table 7 Correlations

		personnel selection	process selection criteria	value addition (proccess)
personnel selection	Pearson Correlation	1	.147	.491*
	Sig. (2-tailed)		.473	.011
	T	-	0.72	2.79
process selection criteria	Pearson Correlation	.147	1	.445*
	Sig. (2-tailed)	.473		.023
	T	0.72	-	2.43
value addition (proccess)	Pearson Correlation	.491*	.445*	1
	Sig. (2-tailed)	.011	.023	
	N	2.79	2.43	-

*. Correlation is significant at the 0.05 level (2-tailed).

It can be observed from the table that the following factors have a higher correlation value and hence are more significant:

Independent Variable	Pearson Correlation values
Personnel selection	0.491
Process selection criteria	0.445

Regression analysis:

Multiple regression analysis has been performed taking into account a each independent variable with dependent variable. This technique has been used to identify a set of variable which conjointly contribute towards process innovation. The notations employed in this test include: Regression coefficient (beta coefficient), R=multiple correlation coefficient

1. Regression analysis of company R&D:

Table 8 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.817[a]	.667	.562	.725	.667	6.352	6	19	.001

a. Predictors: (Constant), government support, management support, range of involvement, technical expertise, infrastructure, funds

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.237	.807		-.293	.773
	Management support	.368	.165	.402	2.224	.039
	funds	-.028	.245	-.019	-.115	.909
	Technical expertise	.480	.194	.365	2.477	.023
	infrastructure	.367	.134	.436	2.727	.013
	Range of involvement	.067	.162	.058	.414	.684
	Government support	-.310	.276	-.166	-1.122	.276

a. Dependent Variable: Value addition of process innovation

From the Table 8 we analyze

- The Adjusted R square value tells us that our model accounts for 56.2% of variation in the dependent variable

The important predictors of the model are given below:

- Management support has significance value(0.039)
- Technical expertise has significance value(0.023)
- Infrastructure has significance value(0.013)

2. Regression analysis of acquiring external knowledge

From the Table 9 the Adjust R Square value represent 37.7% variation in the dependent variable.

The important predictors of the model are given below:

- Adaptability has significance value(0.022)
- Staff competence level has significance value(0.018)

Table 9 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.708[a]	.501	.377	.865

a. Predictors: (Constant), industry assistance, adaptability, funds availability, staff competence level, academia assistance

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.559	1.399		-.400	.694
	funds availability	-.254	.293	-.147	-.867	.396
	adaptability	.501	.202	.435	2.481	.022
	staff competence level	.420	.163	.449	2.572	.018
	academia assistance	.207	.304	.151	.680	.505
	industry assistance	.309	.269	.247	1.149	.264

a. Dependent Variable: value addition (process)

3. Regression analysis of acquisition new machinery

From the Table10 the Adjust R Square value gives 61.3% variation in the dependent variable.

The important predictors of the model are given below:

- Funds availability has significance value (0.080)
- Source capability has significance value(0.007)
- Adaptability has significance value (0.043)

Table 10 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.840[a]	.706	.613	.682	.706	7.588	6	19	.000

a. Predictors: (Constant), tax concession, government funding, funds, outdated technology, source capability, adaptability

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.679	1.312		-.518	.610
	Funds	.285	.154	.301	1.849	.080
	Outdated technology	-.065	.220	-.045	-.297	.770
	Source capability	.560	.187	.459	3.004	.007
	adaptability	.387	.179	.339	2.165	.043
	Government funding	.008	.345	.003	.023	.982
	Tax concession	.016	.167	.012	.097	.924

a. Dependent Variable: Value addition of(process innovation)

4. Regression analyses of training:

The adjusted R square value in Table.11 represents 32.9% variation in dependent variable

The important predictors of the model are given below:

- Personal selection has significance value(0.015)
- Process selection criteria has significance value(0.031)

Table 11 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.619[a]	.383	.329	.897	.383	7.129	2	23	.004

a. Predictors: (Constant), process selection criteria, personnel selection

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.352	.907		-.388	.702
	Personnel selection	.640	.244	.435	2.624	.015
	Process selection criteria	.391	.170	.381	2.300	.031

a. Dependent Variable: value addition of(process innovation)

RESULTS:

The following table represents indicative predictors of the independent variables contributing to process innovation of sample considered.

Company R&D	**Acquiring knowledge**	**Acquisition of new machinery**	**Training**
Management support	Adaptability	Funds availability	Personnel selection
Technical expertise	Staff competence level	Source capability	Process selection criteria
infrastructure		Adaptability	

Chapter-5

Conclusion:

The whole study of process innovation in small scale industries is a pilot study. The study was done in the industrial area of Patiala region in Punjab. The whole survey of 26 industries was done in the form questionnaire which was given to SMEs in the cutting tools sector. The questionnaire was designed to analyze the determinants of process innovation. The activities mainly considered in the terms of company R&D, Acquiring of external knowledge, acquisition of new machinery and training which contribute the process innovation in the industries. The study gives reasonable indications of relationships that exist between considered variable and dependent variable.

As my study is on small number of manufacturing industries, the results are preliminary and only indicative but if the number of sample size of industries is increased, the result will be show additional variables coming into play and also some variations from the existing study in terms of the correlations. In future work regression analysis of combined independent variables can be done with value addition of process innovation while the number of independent variables can be increased for analyze the contribution of process innovation in the industries in totality.

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