

A Comparative Study of Practices for Integration of Sustainability With Innovation for Micro, Small & Medium Scale Manufacturing Enterprises (Msmes) in India and in England

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Abstract- The Brundtland report in 1987 has started a wide dialogue on incorporating sustainability into innovation, that is, the fusion of environmental and social aspects into products, processes, and organizational structures. While previous research has often focused on the large firms, the last decade has seen the main target of research being shifted to small industries that are now being increasingly recognized as main contributors to sustainable development. Also, in case of the Indian perspective, the Indian Government decided to declare 2010 as a Decade of Innovation. So this provides us with an opportunity to create a roadmap for Sustainable Oriented Innovation. MSME have been discussed in brief taking into account the Indian perspective. A study of literature on sustainability, sustainable development, sustainable manufacturing and innovation has been done. The need and benefit of integrating sustainability with innovation have been emphasized. Also, literature is obtained indicating how integrating sustainability with innovation acts as an enabler for MSME's to enhance their opportunities and also to increase their development potential. The manufacturing enterprises in developed (UK) and a developing country (India) which have incorporated sustainability with innovation are compared. Finally, the differences and the similarities in the magnitude of incorporation of sustainable oriented innovation are discussed.

Keywords: Sustainability, Sustainable Development, Innovation, Sustainable Manufacturing, Dynamic Capabilities, Micro Small & Medium Scale Manufacturing Enterprises (MSMEs)

1. Introduction

The year 2015 has been marked the 70th anniversary of the United Nations. It was also the year when countries assembled together to formulate the next generation of goals for our people, and our only home-planet: earth. 2015 has also seen the hosting of the climate conference in Paris. This new agenda will lead the transition from millennium development goals-the MDGs to the next generation of sustainable goals, with a new time frame. There are seventeen goals covering the wider scope of sustainable development agenda, which includes more economic issues such as growth, employment, infrastructure and inequality; environmental concerns that include water, energy, terrestrial and marine ecosystems; and most important is the goal with the aim of promising more peaceful, better governed and inclusive societies. And integrating sustainability with innovation is a step in this direction only.

Various reports of media in the previous couple of years have been investigated and it has been found that enterprises from varied industries are either in the process of launching or are progressing to launch sustainable goods. For the past few years, scholarly investigations on sustainable technologies and manufacturing systems are being explored (Pujari, 2006; Pujari, Peattie, & Wright, 2004). It is not possible nowadays to think about economic development without considering preservation of the environment at the same time and giving shared advantage to the society (Khurana, Mannan & Haleem, 2014). In this way, corporations are routinely looking to exploit extensive variety of input resources which have better productivity and increased responsibility in their products and technologies that are used to manufacture the products (Kedia, Nordtvedt & Chen, 2008). In a highly competitive economic world these days, it is not necessary for the most competing organizations to utilize lower cost inputs any longer (Bosworth & Collins, 2003). Thus, the corporations that have been using performance measuring systems to find out and eliminate resource intensive operations have increased thereby moving towards efficient production models (Akoum, 2009).



Today, the latest patterns demonstrate that corporations are giving a lot of importance to sustainable product innovation; there is a considerable measure of disarray on what makes a green or sustainable good (Baumann, Boons, & Bragd, 2002). In the present study, we pursue Ottman's study who in 2006 stated that there is no user good which has no effect on the surroundings, in industrial terms, the terms 'green good' or 'sustainable good' are majorly used to portray the goods which aim in shielding or upgrading the green habitat by preserving energy and/or resources and also works hard to reduce or eliminate usage of harmful agents, pollution, and waste. This statement accentuates on the means by which varied types of sustainable goods concentrate on important environmental problems, for example, energy, materials/resources, and pollution/ harmful waste.

It is vital to take into account that not all items have a major ecological presence on every step of physical product life cycle. The ecological presence doesn't arise from each and every perspective (material, energy, and pollution) but numerous items have a noteworthy ecological effect in any of the steps. For instance, the company that manufactures furniture impacts mainly the forests (material) but the process of manufacturing washing machine has major ecological impact at the time of the usage of the goods (usage of energy, water, detergent etc). There are numerous different enterprises which have high ecological effect such as automobile and oil whose ecological presence can be substantial as they include all physical life cycle phases (manufacturing, product usage, and disposal). Presenting radical sustainable introduction in any of the phases of product's physical life cycle or dealing with challenges related to sustainability across totally diverse areas like material choice, energy use, or pollution control may lead to major differentiation in the product and creates competition in the market for these products. Innovation in product or processes requires an improved level of corporate responsibility towards environmental issues and also an enhanced level of the companies' implementing environmental policies to initiate the ideas of sustainable product and put them into the right place and beating the difficulties and risks.

The principal motivation behind this study is to propose an integrated model that can help MSMEs develop innovation capabilities which can enable them manufacture innovative products which are environmentally and commercially sustainable. This research primarily throws light on manufacturing sector because to the following reasons: (i) increased possibility to influence environment such as air pollution, effluent run-off and improper disposal of solid wastes; (ii) novel technologies to cleaner processes as well as procedure which are not proceeding at a fast measure to portray the compelling need for environmental protection.

The main motivation behind choosing MSMEs that they are huge in numbers, survives with weak compliance to environmental norms, generally operated by owner-managers, develops or borrow technology without much concern to environment, normally there is no systematic framework in place for sustainability cross-check, paucity of sophisticated equipment and testing facility, and could be extremely polluting. Because MSMEs have tremendous potential for creating jobs for skilled and unskilled workers they enjoy tacit and explicit support of all governments across the globe. On this very count many a times the environmental agencies turn a blind eye to MSMEs' record on environmental-friendliness compliance. It is not very difficult to visualize that many MSMEs which are operating on poor environmental sustainability; they could make healthy life unsustainable in that part of the country and eventually start damaging the environment of the whole country or world. Another aspect is, if the MSMEs grow big without a concept or concern for sustainability then they will become an even bigger threat to the world environment.

2. Literature Review

2.1 Background

Recently, a survey was conducted by McKinsey and Company (2008) on companies' concern on climate change, and it was concluded that the highest rate of executives' reviewed take into account climate change essential, and about 60% consider creating and showcasing new items important. As stated in Data monitor, organizations have up till now introduced 458 goods that claim to be "sustainable," "eco friendly," or "natural habitat friendly," and this figure will touch to 1570 new sustainable goods to be introduced in the coming year. For instance, development of soy-based seat cushion foam by Ford, elimination of the restricted ingredients by green list process as done by SC Johnson, and announcement by Lipton Tea of the enlargement of their program on sustainability, assuring to provide their tea from sustainable estates.

This encouraging attitude by the firms directs a distinct change in the environmental discussion pointing out that moving towards environmental value and social good is due to the product innovation driven by market and latest technologies instead of regulation only.

Also, the environmental issues like pollution and depletion of fossil fuel resources have become issues that are concerning the international organisations, national government and consumers. Recently, the OECD (2009) report suggested that the worldwide greenhouse gas emissions are most likely to increase by 70% by 2050. This has led to the augmented importance of sustainable development concept. This concept has been taken as a standard for the economic, environmental and social policies integration by the companies affecting their manufacturing processes and also their competitiveness (Bloom & Van Reenen, 2002). Thus innovation process incorporating development which is sustainable has received increased attention during the past years.

2.2 Micro, Small and Medium Scale Enterprises

They are a heterogeneous cluster as far as size and sector diversity is concerned (Hillary, 2004) and overall, it is not easy to clearly outline what an MSME is, because countries adopt different criteria (e.g. employment, sales, and turnover) for definition purposes. But, generally the MSMEs are outlined by the number of employees with a threshold between 100 and 500 (Ayyagari, Beck, & Demircuc-Kunt, 2007). They assume a vital part within the developing countries by adding to the national economic yield and in generating employment and are taken as drivers for expansion of the economy and advancement (Khurana, Khan & Mannan, 2013). These enterprises are there in all large production sub-divisions (food processing (tea and desiccated coconut), textile, foundry, brick and ceramic, etc.) and consist of 85% of the total number of producing enterprises in Asia. In China, over 99% of enterprises come in the category of small and medium scale enterprises. In various Asian countries, MSMEs represent 60–70% of the industrial production held domestically and contributes to 75–80% of the export revenue (Vepa, 1997). In many of the Asian countries, approximately 60–70% of the total labour force in the manufacturing sector is employed by the SMEs (Khurana, Khan & Mannan, 2012). This article focuses on to develop sustainable development through technological innovation in micro, small- and medium-scale enterprises which have got attention from the government entrepreneurs in the country.

Also, MSMEs build a large group internationally which, for instance, data for OECD economies show where MSMEs make out between 96% and 99% of the total number of enterprises (OECD, 2009). MSMEs as a group contribute to a large share of overall pollution. The EU MSMEs account for approximately 64% of pollution. They are not thought of as subparts of their larger industries (Ullah, Abbas & Akbar, 2010) and fourth ‘SME peculiarities’ imply that they will innovate differently for sustainability (Moore and Manring, 2009).

2.2.1 Micro, Small & Medium Scale Industries: Indian Perspective

For the last three decades, proper economic development in our country has taken place under certain severe constraints (Mannan and Khurana, 2012). The more vital of these constraints are: inadequacy of resources along with capital, equipment, technology, skills, etc., high growth rate of population, and adverse land-man ratio (Mannan, Khurana and Haleem, 2016). Besides this, the establishment of basic and heavy producer goods industries, that is an important pre-requirement for laying the base of rapid industrialisation, economic growth involves a heavy strain on restricted resources of capital and skills and provides limited employment opportunities (Husain & Sushil, 1997). It is in this context that great emphasis has been placed in our industrial

policy statements and programmes for the promotion and development of small industries which does not make high demand on scarce capital resources and also creates much larger opportunities for employment, including self-employment (Khurana, Khan & Mannan, 2012).

According to the Fourth All India statistics of MSME (Micro Small Medium Enterprises) 2006-07, the MSME sector approximately provides employment to 80.523 million people with the help of estimated 36.176 million enterprises. Of the total number of enterprises, 55.34% were in rural areas while 44.64% were in urban areas. 68.21% of the enterprises were engaged in services with remaining 31.79% engaged in manufacturing.

The MSME sector has a tremendous potential to cater to the issues of providing employment to the growing population (Mannan, Khurana & Haleem, 2012). Acknowledging the wide potential of innovative firms and agriculture based industries in MSME sector, the budget speech 2014-2015 delivered by the Hon'ble Finance Minister in the Parliament on 10-07-2014, said: "To establish Technology Centre Network to promote Innovation, Entrepreneurship and Agro-Industry, I propose to set up a fund with a corpus of INR 2000 Million." It would be taken up for incorporation of fresh ideas and to provide essential buttress for accelerating entrepreneurship." The Hon'ble Prime Minister, in his Independence Day speech in 2014 had also stressed on developing 'zero defect' products so that the probability of getting rejection from the world market is very less and 'zero effect' so that the manufacturing process does not harm the environment. Thus this provides us with a huge potential to incorporate sustainability into innovation in case of Indian MSMEs.

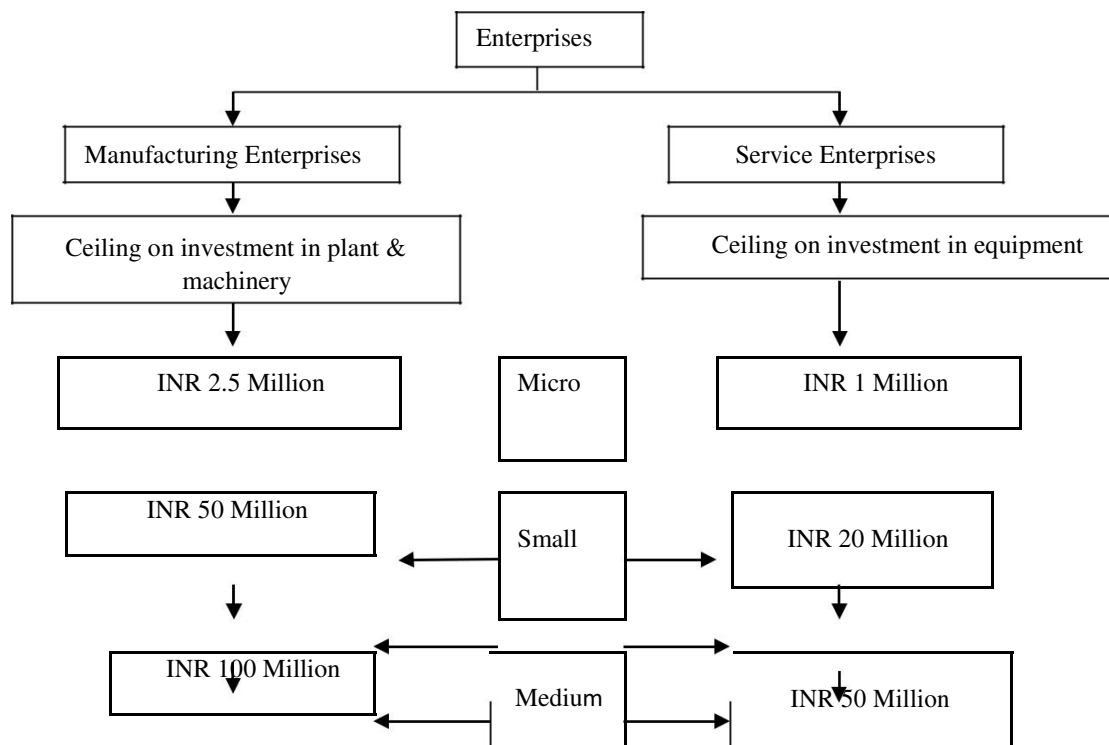


Figure 1: Structure of the Small & Medium Scale Enterprises (Source: Khurana, Khan & Mannan, 2012)

2.3 Sustainability

The Forestry Commission of Great Britain outlined sustainability with four goals. First, it is for social progress that acknowledges the need of everybody. Second, it is for effectiveness of the protection of the environment. Third, it ought to pursue judicious use of natural resources. At last, it is for maintaining of high and balanced levels of growth of the economy and generation of employment. The US National Research Council defined the sustainability as "the level of

human consumption and activity, which might continue into the foreseeable future, so that the systems that provides goods and services to the humans, persists indefinitely”.

The above mentioned researches are mainly concerned with the definitions of sustainability and sustainable development at the conceptual and abstract perspective. And, these ideas are associated with managerial issues such as social, economic, and environmental purposes. However, the features of sustainability can be expended by adding some other factors or by specifying the in depth composition of sustainability (Mannan, Khan & Khurana, 2013). The MSA (Manufacturing Skills Australia) developed the operating definition of sustainability with additional detailed specifications in terms of environmental, social, and economic factors. It is divided into internal and external factors. As an example, the internal factors of environmental sustainability are to reduce the cost and waste. Also; Werbach outlined sustainability with four components: social, economic, environmental, and cultural. It had been outlined by adding the cultural construct, which implies, to safeguard and understand the worth of diversity through which communities manifest their identity and develop traditions across generations, to the general definition. Along with these researches and studies, sustainability can be mainly defined in social, environmental, and economic perspective (Mannan, Khan & Khurana, 2012). And it may be extended with additional general or specified factors in interdisciplinary area (Mannan, Khan&Khurana, 2013). In this paper, sustainability in manufacturing or sustainable manufacturing is reviewed based on the existing definitions in following section (Mannan, Khurana, & Haleem, 2016).

Table 1: Sustainability Definition by various researchers

| S. No. | Reference | Definition of Sustainability |
|--------|--|---|
| 1 | The Forestry Commission of Great Britain | First, it is for social progress that acknowledges the need of everybody. Second, it is for effectiveness of the protection of the environment. Third, it ought to pursue judicious use of natural resources. At last, it is for maintaining of high and balanced levels of growth of the economy and generation of employment. |
| 2 | Werbach, A | He outlined sustainability with four components: social, economic, environmental, and cultural. It had been outlined by adding the cultural construct, which implies, to safeguard and understand the worth of the diversity through which communities manifest their identity and develop traditions across generations. |

We have referred to sustainability in total in this article, but we will allow for narrower approaches dealing with a selected sustainability dimension, particularly ecology, as firms often focus on or initiate the enhancements in either environmental or social dimensions in their path toward sustainability (Klewitz & Hansen, 2014).

2.3.1 Sustainable Development

The term got importance after 1987, when in the Brundtland report, the United Nations' World Commission on Environment and Development outlined the *sustainable development* as

development that “meets the needs of the present generation without compromising the ability of future generations to meet their own needs.”

Along with the greater concern to the social, environmental, and other important issues, all existing methods, technologies, and paradigms are required to be innovated in terms of the win-win approach that is sustainable for the our future(Mannan,Khan & Khurana , 2012). This idea can be applied to economy, management, policy, social operation, and manufacturing technology. The World Commission on Environment Development (WCED) report (later published as a book “Our Common Future”) outlined that the sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Sustainable development gives us a new direction of thinking thoroughly considering and overseeing human effect on the world – one that can create enduring advantages for all of us (Kumar, Luthra, & Haleem, 2013). Two points are important to sustainable development. In the first place, the conclusion that the growth of the economy alone is insufficient in resolving the world’s issues: those related to economy and ecology and other aspects of any process are connected with each other. Taking only one of these at a time will cause errors in judgment and “unsustainable” results. Dealing solely on net revenues has conventionally prompted social and environmental harms that affect the general public in the long run (Husain, 2014).

The most important issue for the development to be sustainable is the urgency to take into account “three pillars” simultaneously: society, the economy and the environment (Lee, Kang, & Noh, 2012). Whatever the case may be, the primary logic is not changed – human beings, environment and systems related to economy are interconnected. We may not give emphasis to their interconnection for couple of years more; however history has frequently reminded us of the interconnection by some form of alarm or crisis.

Every nation’s historical, economic, social and political setting is different from the other; however the fundamentals of sustainable development apply to all. Economic growth is important; however growth alone, while not seeing all the elements that add to well-being, does not decrease poverty sustainably (Husain & Sushil, 2000).

Manufacturers are planning to design greater number of products that appeal for their aesthetic qualities or their ease of usage as well as for their ecological and social sustainability (Husain, 2016). The changes in awareness of the consumer and the multiplication of increased number of sustainable items and services in the course of recent years are encouraging. Some critics and consumer advocates correctly bring up that some of this is often “fluff” or “greenwashing”. Items that claim to be ecologically friendly can’t actually be so once you investigate at the list of ingredients or analyse the complete product life cycle (Luthra, Kumar, Kumar, & Haleem, 2011). The fact that greater number of people and businesses perceive and even want to capitalise on this realisation demonstrates the increasing mass appeal of sustainability.

2.3.2 Sustainable manufacturing

Manufacturing industries are highly effective in terms of sustainability (Haleem, Sushil, Qadri, & Kumar, 2012). This is because various kinds of problems, which are associated with social,

economical, and environmental issues, can be caused by the manufacturing process (Luthra, Kumar, Garg, & Haleem, 2015). Thus, it is very essential to implement manufacturing processes with sustainability. That is sustainable manufacturing. A lot of research has been done about definition and concept of sustainable manufacturing. National Council for Advanced Manufacturing (NACFAM) of U.S.A. outlined that the concept of sustainable manufacturing incorporates the manufacture of products which are sustainable and the manufacturing sustainably all the products. Manufacturing using renewable sources of energy, energy efficiency, green building, and other sustainable & social equity-related goods are related to sustainable product (Cooper, 1990). Also, manufacturing sustainably the majority of products involves taking into consideration the complete sustainability/full life cycle issues related to the goods manufactured.

Lowell Center for Sustainable Production (LCSP) outlined that the production which is sustainable is “*the creation of goods and services using processes and system that are: Non-polluting, Conserving of energy and natural resources, economically viable, Safe and healthful for workers, communities, and consumers, and socially and creatively rewarding for all working people*”.

Park, Craggs, & Shilton (2011) researched about the technology that aims to reduce energy consumption in manufacturing sector by studying various policies, standards, and researches and their reviewing research shows various information and data which can be helpful for the development of energy-saving and sustainable technology in manufacturing sector.

LCA (Life Cycle Assessment) is established based on ISO 14040-14049 for investigating the impacts of both manufactured and consumed products on environment. And Eco-Indicator 95 and 99 are made to find out the damage impacts on human health, ecosystem, resource, etc However, these methodologies do not concentrate on the most vital issues of manufacturing company, which are on economical impact of production.

Many studies and researches on sustainable manufacturing show numerous basics and definitions of sustainable manufacturing, but they are just conceptual or constrained within the range of analysis such as damage effects on human health and ecosystem. Thus, systematic, structured, and integrated approach is required for practical application of sustainable manufacturing.

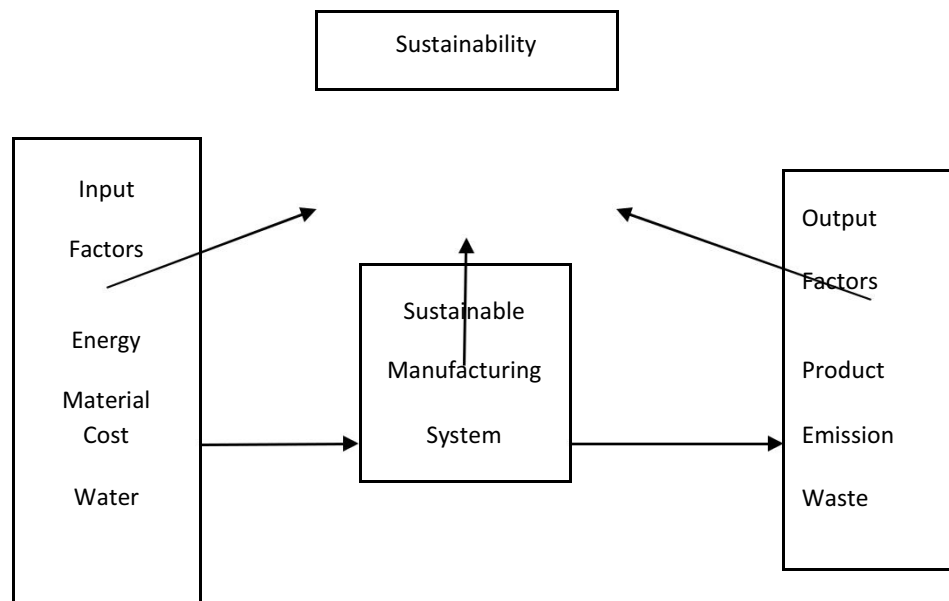


Figure 2: Sustainable Manufacturing System (*Adopted from: Choi, Lee, & Ham, 2016*)

Figure 2 depicts the composition of sustainability factors with the sustainable manufacturing system. With the existing definition of sustainability and sustainable manufacturing, various types of energy, physical materials, water, cost, package, and human resource are input factors of sustainable manufacturing system, and the quantity of manufactured product and generated emission/waste are output factors of sustainable manufacturing system.

In case of energy, it can be used such as gas, oil, electricity, etc. Material depicts the all kinds of substances to be made to product. Water is generally industrial water. The prices are fixed. Packages are various materials for packing products. Human resources include direct/ indirect labors. Emission includes various green-house gases such as carbon dioxide, methane gas, nitrous oxide, etc. Waste includes solid and liquid wastes. Thus, emission and waste should be reduced against the quantity of manufactured product.

2.4 Innovation

Schumpeter (1934) is generally regarded to be among the first to think of the procedure of innovation in organizations. According to him, innovation is considered as the formation and execution of combinations which are novel or different. These different combinations can be associated with novel goods, services, work processes, markets, delivery systems and policies.

“Innovation is the particular instrument of entrepreneurs, the method by which they exploit change as an open door for a different business or service.” (Drucker, 1985)

“It is the heart and the way of thinking of entrepreneurship” (Drucker, 1998)

Innovation is economic and social achievement which is obtained by introducing novel ways or novel combining of present approaches in the input-output conversion that majorly change the relationship between utility value and price of good which is given to consumer and or user, community, society, and environment (Fontana, 2009).

Innovation is “the successful development, execution and usage of fresh or structurally improved items, procedures, services or organisational forms” (Hildrum, 2007).

Innovation is more comprehensive than creativity or Invention (Rothwell, 1992). An invention is an imagination, sketch or an idea for novel concept or a better device, good, procedure or a

system, but, an innovation is achieved with first commercial implementation involving an invention (van der Panne, van Beers, & Kleinknecht, 2003). An invention becomes innovation once it enters the economic system (Grossman & Helpman, 1994; Bowonder & Miyake, 1988).

Table 2: Definition of innovation by various Researchers

| S.NO | REFERENCE | DEFINITION |
|------|------------------|--|
| 1. | Schumpeter(1934) | He depicted innovation as the creation and implementation of different combinations. |
| 2. | Drucker (1985) | Innovation is the particular instrument of entrepreneurs, the method through which they explore new ideas or innovation as an open door for a new business venture or service delivery. |
| 3. | Drucker (1998) | Innovation is the heart and the way of thinking of entrepreneurship. |
| 4. | Hildrum (2007) | Innovation is “the successful development, execution and usage of fresh or structurally improved items, procedures, services or organisational forms” |
| 5. | Fontana(2009) | Innovation is economic and social achievement which is obtained by introducing novel ways or novel combining of present approaches in the input-output conversion that majorly change the relationship between utility value and price of good which is given to consumer and or user, community, society, and environment |

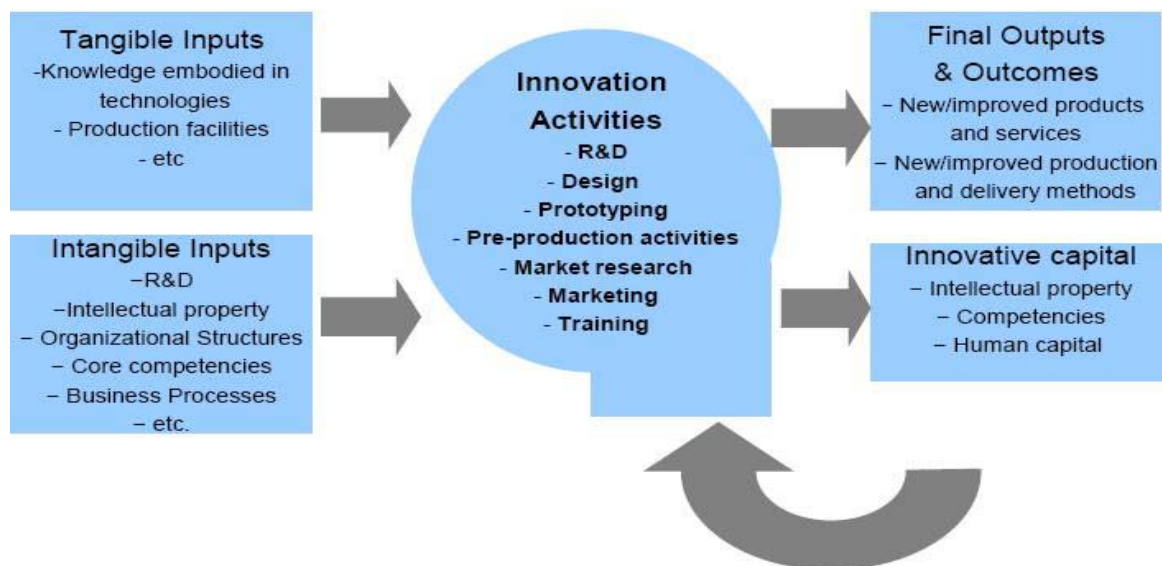


Figure 3: A typical system of innovation (Source: Rose, Shipp, Lal & Stone, 2009)

Innovation/Introduction is differentiated in the following forms:

- Good and Procedure Introduction
- Technological and Organisational Introduction
- Radical (or Revolutionary) and Incremental (or Evolutionary) Introduction
- Disruptive (or Discontinuous) and Sustaining (or Continuous) Introduction

- Open (External) and Closed (Internal) Introduction
- Component level and System level Introduction

Good and procedure introductions are considered as a very crucial innovation activity of the companies (Alum & Drucker, 1986).

Open innovation has been applied by the food industry in the recent times.

Practicing innovation is the desire on the part of policy makers to capitalize on the full potential of advanced technology that has become available in the wake of globalization of economies (Husain, 2016, Galanakis, 2006). Depending on the stage of adoption and degree of success, the firms can be classified as (Docherty, 2006):

- If the company introduces innovation under the period of review, then the same is termed as the innovative firm. It is not necessary for the innovations to be a commercial success and many a times, innovations fail.
- If the innovation activities are going on during the period under review, then the firm is called as the innovation active firm. It is not necessary whether the exercise concluded in the execution of an introduction.
- An introductive active firm in which innovation efforts have been made but have not been successful in converting them into innovations is termed as potentially innovative firm.

2.5 Integrating Sustainability with Innovation for Indian Manufacturing Enterprises

2.5.1 Need for Integrating Sustainability with Innovation for Indian manufacturing Enterprises

According to Dangayach & Deshmukh (2003), 'reforms in the economic sector and competition globally have given an opportunity for the Indian manufacturing companies to see the key role of manufacturing'. This has given motivation to Indian enterprises to give high focus to quality and technology management.

Ganapathy (2014) argued that Indian manufacturing enterprises are working hard to enhance their sustainable performance in order to satisfy multiple stakeholders. Sustainable oriented innovation is an upcoming approach which reduces environmental impact and influences enterprises to improve the business performance.

Thirupathi & Vinod (2016) studied sustainable manufacturing practices in Indian automobile manufacturing sector and found that sustainable manufacturing practices are vital for automotive manufacturing enterprises in order to have competitive advantage in terms of cost, quality, delivery, flexibility, research and development. Thus, Indian manufacturing enterprises need a sustainable manufacturing strategy for survival in global arena.

Innovation can be considered as an important force for greater efficiency and increasing the competition in the market, and also, with the help of collaborative approaches and comprehensive growth, it helps in allaying poverty (Mannan, Khurana & Haleem, 2012; Husain

& Sushil, 2000). Besides this, innovation has always been the approach through which individuals tackled the major difficulties confronting the society (Arora & Nath, 2015; Gaynor, 2002). The probability of draining assets faced by the world has increased and demand has exceeded the supply. The worldwide food system is attempting to cater to the increasing demands and the World Bank estimates an increase of 50 per cent in global demand for food by

2030 (Bessant & Bessant, 2003). Such types of gap will be observed in the supply of water, and increased consumption of energy will lead to high pressure on the system. Energy consumed by Asia alone is approximated to become twice in the coming decade– to about 48 per cent for oil and 22 per cent for natural gas. Such major problems can only be taken care of by sustainable innovative solutions (Dangelico and Pujari, 2010). This data from the review of the literature motivated to perform this research on incorporation of sustainability with innovation for Indian manufacturing enterprises.

2.5.2 Comparative Case Study involving MSMEs in Bangalore and North East England The main aim is to investigate and compare the manufacturing enterprises in developed (UK) and a developing country (India) which have incorporated sustainability with innovation.

This research is focussed on small enterprises in the engineering industry in (1) the northeast of England comprising Durham city and Sedgefield districts of Durham county and the city of Sunderland in the UK, and (2) Bangalore urban district in Karnataka state of India. The former is known for its cluster of manufacturing enterprises, particularly that of engineering (Subrahmanya, 2001). The Bangalore urban district is an industrially better developed region in India and is known for its concentration of engineering and electronics industries (Subrahmanya, 2001). There are approximately 337 medium and large industrial enterprises and about 30,000 small-scale industrial units located in and around Bangalore (Government of Karnataka, 2000b). In Bangalore, the inclination was on Peenya Industrial Estate. Peenya Industrial Estate is one of the largest and oldest of its kind in the whole of South and Southeast Asia.

After an in depth review of the literature, case studies of two countries were compiled to draw out similarities and differences in the pattern of sustainable oriented innovation followed by the MSMEs in two countries.

The basic characteristics of small engineering enterprises of Bangalore and Northeast England are described in terms of employment size.

Table 3: Distribution of small enterprises by employment (Source: Subrahmanya, 2005)

| Employment size class | Bangalore | NorthEast England |
|-----------------------------|-----------|-------------------|
| Up to 10 | 13 | 9 |
| 11-50 | 21 | 18 |
| 51-100 | - | 7 |
| Total Number of enterprises | 34 | 34 |

2.5.3 Sustainable Oriented Innovation in MSMEs: Analysis of patterns

2.5.3.1 Dimensions

Sustainable Oriented Innovations of micro, small and medium scale engineering enterprises may take place through the following dimensions (Subrahmanya, 2005):

- New product development
- Substitution of raw material to make it more sustainable
- Changing product design
- Training given to the employees for enhancing internal R&D
- Adoption of life cycle approach
- Energy conservation

Table 4: Sustainable Oriented Innovation in MSMEs: Bangalore (Source: Subrahmanya, 2005; Author's own elaboration)

| Factors ↓ Dimension | Self Motivation | Customer Needs | Competition | Government Rules & Regulations |
|---------------------------------|-----------------|----------------|-------------|--------------------------------------|
| New product development | 2 | 10 | 6 | - |
| Use of substitute material | - | - | 10 | 9 |
| Changed product design | - | 19 | 11 | - |
| Training given to the employees | - | 8 | 9 | 12 |
| Adoption of life cycle approach | - | 8 | 10 | - |
| Energy conservation | - | - | 2 | 15 |

The factors which influence the integration of sustainability with innovation are as follows:

- Self motivation
- Customer needs
- Competition
- Government rules & regulations

These factors have been selected based upon the review of literature from various international journals on sustainable manufacturing in MSMEs.

Table 5: Sustainable Oriented Innovation in MSMEs: North East England (Source: Subrahmanya, 2005; Author's own elaboration)

| Factors ↓ Dimension | Self Motivation | Customer Needs | Competition | Government Rules & Regulations |
|---------------------------------|-----------------|----------------|-------------|--------------------------------------|
| New product development | 10 | - | 3 | 9 |
| Use of substitute material | 5 | - | - | 5 |
| Changed product design | 16 | 12 | 5 | - |
| Training given to the employees | 18 | - | 2 | - |
| Adoption of life cycle approach | 15 | 6 | - | - |
| Energy conservation | 20 | - | - | 6 |

2.5.4. Similarities in the magnitude of sustainable oriented innovation

An increased proportion of small enterprises in North East England than in Bangalore have embarked upon sustainable oriented innovations of one kind or the other. In the same way, an increased proportion of innovating small enterprises in Northeast England (ten out of 22) than in Bangalore (two out of 18) have achieved 'radical innovation' by developing novel products and obtaining 'product patents'. But, the greater part of the small enterprises in both the regions are working in the area of 'incremental innovations', majorly characterized by changing product designs. The incremental innovators are mainly driven by customer needs and/or guidance and support. Thus, there are similarities in the patterns of sustainable oriented innovations carried out by small engineering enterprises in both Bangalore and Northeast England. But, a major proportion of these enterprises are working in the area of radical as well as incremental innovations in Northeast England than in Bangalore.

The incremental innovators, on the other hand, are mainly focussed on changing product designs. In Northeast England, incremental innovations are mainly driven by self motivation and are carried out either independently or with customer support. In Bangalore, on the other hand, incremental innovators are of two kinds: (i) those who are driven by customer needs; (ii) those who are driven because of competition in the market and innovated with customer support to meet customer needs.

2.5.5. Differences in the magnitude of sustainable oriented innovations

Though Bangalore is viewed as the only 'global hub of innovation', this designation has been given to the region more because of its advancements in the area of information and communication technologies (ICTs). Thus, it is called 'the Silicon Valley of India' (Government of Karnataka, 2000b). India is acknowledged as a 'dynamic adopter' (UNDP, 2001) of novel technologies and not a 'potential technology leader', as compared to the UK. Although countries like India are viewed as progressive adopters of new technologies, the diffusion of old inventions is slow and incomplete (UNDP, 2001).

The R&D pace of India is much lower than that of developed countries such as the UK, the US, Japan, France, Sweden and Switzerland. The average R&D intensity of these countries was 2.25 in 1981, 2.68 in 1991 and 2.80 in 1993 as against India's 0.62 in 1981, 0.85 in 1991 and 0.86 in 1993 (DST, 2000). Although countries like India have drawn much attention as potential economic powers, they have not been investing rapidly enough to improve their innovative capacity across economic sectors to levels similar to OECD countries (Council on Competitiveness, 1999).

3. Conclusions

The acknowledgement that we are living in a world with limited resources is pushing activities towards greater sustainability. The requirement to evade unsustainable procedure has been a test for various decades now, but today it is progressively being taken into account with increased direness. The requirement for carrying out increased sustainable production and consumption practices has increased. It has changed the way the solution is needed. We have to increase our pace of using sustainable practices in a relatively brief time period. And this requires changes which are radical in nature and also should take into consideration the changes in complete product structure or arrangement. In this sense, sustainability is taking towards an increased recognition of the requirement for innovation. Enhancing innovation potential is integral to achieving increased productivity levels and is imperative for achieving and sustaining the overall competitiveness of an economy.

This paper has also tried to find out the pattern of sustainable oriented innovations followed by small enterprises in the engineering units in Bangalore as compared to those of Northeast England. The pattern is developed based on (1) the factors that influence the sustainable oriented innovations, and (2) the dimensions of sustainable oriented innovations. Based on this pattern between the two regions, the similarities and dissimilarities are analyzed. Sustainable oriented innovations of small enterprises may be carried out in different ways depending upon various factors, internal as well as external to an enterprise. But the factors and dimensions of sustainable oriented innovations, radical or incremental, in small engineering enterprises appear to be similar between the northeast of England in the UK and the Bangalore urban district in India.

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