Determinants of Green Innovation Adoption for Small and Medium-Size Enterprises (SMEs) in Telangana

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ABSTRACT
This research investigates the factors that impact small and medium-sized businesses' (SMEs) in Telangana's adoption of green innovations. SMEs have possibilities and problems when it comes to incorporating green practices into their operations as environmental sustainability gains importance. The adoption of green technologies is influenced by a number of important aspects, which this study examines. These factors include financial restrictions, market demand, regulatory pressures, and technological capabilities. This study used a mixed-methods approach to investigate the influence of several factors on the decision-making process connected to green innovation. It includes surveys and in-depth interviews with managers and owners of SMEs. The results show that market incentives and governmental backing are important drivers, whereas financial limitations and restricted access to cutting-edge technologies are major obstacles. Green innovation initiatives can also be aided or hindered by corporate culture and managerial commitment.

Keywords: adoption of green innovation, small and medium-sized firms (SMEs), technological innovation, and innovation determinants.

INTRODUCTION

Small and medium-sized businesses' (SMEs) adoption of green innovation is becoming more widely acknowledged as a crucial element of sustainable development, especially in developing nations like India. SMEs are essential to Telangana's industry diversification, economic expansion, and creation of jobs. These businesses do, however, also have to contend with a number of formidable obstacles, such as limited resources, fierce rivalry, and changing environmental laws. Green innovation provides SMEs with a means of improving their sustainability and competitiveness. It is the creation and application of innovative goods, procedures, or activities that minimize environmental effects.

Many factors influence the adoption of green innovations by SMEs in Telangana. These elements fall into two general categories: internal and external forces. Stakeholder impacts, such as supplier obligations and customer preferences, as well as market demand and regulatory pressures are examples of external variables. The firm's resources, technological prowess, organizational culture, leadership dedication, and environmental awareness are examples of internal influences.

Numerous scholars have put forth diverse theories about the elements that impact companies' adoption of environmentally friendly technology (Gadenne et al., 2009; Henriques and Sadorsky, 1999; Ho and Lin, 2011). Environmental factors, stakeholder pressure regulation, the size of the organization, the traits of the managers, The industrial sector and human resources are pertinent. Variables were common in related studies (Etzion, 2007; Gonzalez-Benito (2006); Gonzalez-Benito, both authors).The This paper's primary goal is to investigate the elements that influence the adoption of green innovations by small and medium-sized businesses (SMEs) by taking stakeholder pressure and technological innovation into consideration.

It is necessary to investigate novel resource combinations and repurpose current resources in order to incorporate environmental requirements into business operations (Hart, 1995; Lin and Ho, 2011). Adoption of green innovations entails applying updated or new methods, procedures, and mechanisms to lessen damage to the environment. Since invention is the use of fresh administrative and technological expertise, Using environmentally friendly techniques might be seen as an process of invention. Numerous investigators (Henriques and Sadorsky, 2007; Rothenberg and Ho, 2011; Lin and Environmental concerns are analyzed from Zyglidopoulos (2007) the viewpoint of innovation. The majority of them offer an

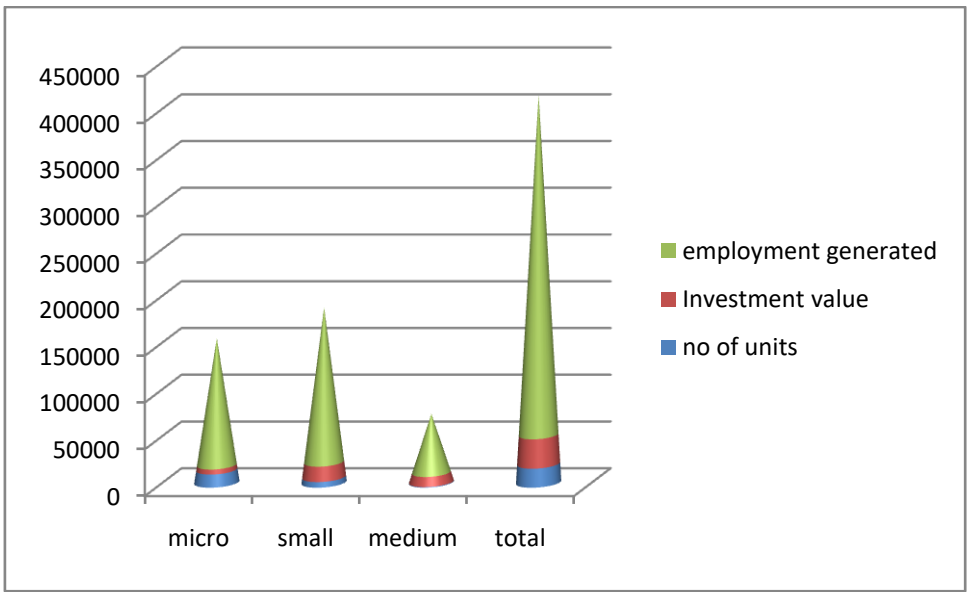
understanding of the effects of specific organizational and environmental influences on innovative green practices. As an illustration, According to Del Brio and Junquera (2003), financial manufacturing activity, technological approach, people resources, managerial style, and innovation ability, and Henriques and Sardosky (2007) argued that total quality management and external stakeholder pressure would increase the likelihood that Canadian manufacturing companies implement cleaner technical innovations. In a study of the printing industry, Rothenberg and Zyglidopoulos (2007) found that the adoption of green innovations was positively associated with the dynamism of the company‟s task on the environment. However, little empirical study analyzes how technological, organizational and environmental factors simultaneously influence the adoption of green innovations. Lin and Ho (2011) have found that the adoption of green practices for logistics companies was influenced by technological organizational and environmental factors. In addition to stakeholder pressure, organizational and external environmental factors are two factors commonly considered in the studies of green innovation (Etzion, 2007; Gonzalez-Benito and Gonzalez-Benito, 2006) Scarce attention has been paid to the influences of technological characteristics on green innovation (Lin and Ho, 2011). Literature on technical innovation suggests that the nature of technology, the capabilities of the organization and the external environment are three general characteristics affecting the adoption of new technologies (Chau and Tam, 1997; Tornatzky and Fleischer, 1990). Characteristics of a new technology such as compatibility, complexity and relative advantage may affect its adoption (Jeyaraj et al., 2006; Lin and Ho, 2011; Rogers, 2003; Tornatzky and Klein, 1982). Boiral (2002) argues that characteristics of environmental knowledge are relevant in environmental management. Therefore, technological characteristics should be taken into account when analyzing the adoption of green innovations for the SMEs. To fill the research gap, this paper studies the influences of technological, organizational, and environmental factors on the adoption of green innovations. Also, this study investigates the influences of stakeholder pressure on the adoption of green innovations because stakeholder pressure is a prominent factor influencing a company‟s environmental strategy (Buysse and Verbeke, 2003; Sharma and Henriques, 2005). Traditional green innovation adoption frameworks have repeatedly shown the strong explanatory power of stakeholder pressure. Drawing on theories of technical innovation and stakeholder pressure, this paper attempts to contribute a new model to research on green innovation adoption. An understanding of the influencing factors is essential for practitioners to best implement green innovations and for researchers to best understand the issues that need to be addressed. This paper will focus on the green innovation adoption of SMEs in China. SMEs have played a relevant role in China‟s economic development. Due to the global trend of environmental protection, SMEs in China have begun to take environmental issues into consideration. Company size has been repeatedly taken as a relevant organizational characteristic influencing companies‟ technical innovation (Kimberly and Evanisko, 1981) as well as environmental activities (Del Brio and Junquera, 2003; Etzion, 2007; Gonzalez-Benito and GonzalezBenito, 2006). In general, large companies tend to adopt green innovations more easily than small ones because they have sufficient resources and strong infrastructures. Small companies, in contrast, may suffer from the lack of financial resources and professionals, which results in difficulties in adopting green innovations. Some researchers have analyzed the green behavior of SMEs (for example, Gadenne et al., 2009; Roberts et al., 2006; Simpson et al., 2004). Much remains to be learned empirically about the factors influencing green innovation adoption for SMEs.

An Overview of Telangana

In Telangana, the adoption of green innovation by SMEs is particularly relevant due to the state's focus on becoming a hub for sustainable industrial growth. With initiatives like the Telangana State Industrial Project Approval and SelfCertification System (TS-iPASS), the government has been encouraging industries to adopt eco-friendly technologies. However, challenges such as lack of awareness, financial constraints, and limited access to technology persist, which need to be addressed to enhance the adoption rates of green innovation among SMEs. Understanding these determinants and addressing the barriers can help policymakers, industry bodies, and the SMEs themselves to create an enabling environment for green innovation. By leveraging the determinants effectively, SMEs in Telangana can not only improve their environmental performance but also gain a competitive edge in the market. This introduction sets the stage for exploring the various factors that influence green innovation adoption in SMEs within Telangana, offering insights into how these enterprises can navigate the complexities of sustainability in a rapidly evolving industrial landscape.

Table 1.0

Category	No. of Units	Investment Value (in INR Cr)	Employment Generated
Micro	13,546	5,099	1,35,547
Small	5,830	15,946	1,65,242
Medium	578	9,978	62,699
TOTAL	19,954	31,023	**3,63,488**



Environmental Performance

The environmental performance refers to the initiatives of an organization for meeting and exceeding their social expectations in the natural environment, in a way to go beyond the mere acquiescence with regulations and procedures. It considers the environment-related influences of processes, as well as the consumption of resources and products, in a manner that best fits the legal requirements of the environment Past research studies indicated that the green performance of a firm is wholly dependent on the quality of the green products, eco friendly behaviors, green practices, and green style of leadership, in addition to incorporating ecological sustainability in its business operations

Lean and Sustainability

Lean manufacturing includes many tools, e.g., Muda, Jidoka, Just-in-Time (JIT), Value Stream Mapping (VSM), Kanban, Poka Yoke, Kaizen, 5S system, Root-case analysis, Zero defects. To understand how "lean" affects sustainability, each principle and its impact should be considered. Muda (or wastes) is any activity that consumes resources and time but does not create value. A labor management and is useful in transparent production flow and elimination of economic waste. Additionally, it is suggested to complement VSM with 5S and Kaizen while dealing with air pollution. Many articles disregarded the relationship between Lean and social sustainability due to lack of resources because as Tasdemir argues, the social pillar gained the least attention. Overall, Lean principles and tools are positively associated with general sustainability and their synergies are advised despite some barriers lean concept, in general, considers seven main losses: overproduction, defects, waiting, over-processing, unnecessary or ineffective inventory, motion

Industry and Sustainability

Industry and sustainability are two interlinked concepts that are crucial for achieving balanced economic growth and environmental protection. As industries continue to expand and evolve, there is an increasing need to align industrial activities with sustainable practices that ensure the long-term health of our planet. This alignment is essential for mitigating the negative impacts of industrialization, such as pollution, resource depletion, and greenhouse gas emissions, which contribute to climate change and environmental degradation.

The Role of Industry in Sustainability

Industries play a significant role in driving economic development by providing jobs, generating income, and fostering innovation. However, traditional industrial activities often come with substantial environmental costs. To address these challenges, industries are increasingly adopting sustainable practices that focus on minimizing environmental impacts while enhancing economic and social value. Key aspects include:

- **Resource Efficiency**: Implementing practices that reduce the consumption of raw materials, energy, and water, thereby lowering the overall environmental footprint.
- **Pollution Reduction**: Reducing emissions of harmful pollutants through cleaner production technologies, waste minimization, and recycling efforts.
- **Sustainable Supply Chains**: Ensuring that the entire supply chain, from raw material sourcing to product distribution, adheres to sustainable practices.
- **Green Innovation**: Developing new products, processes, or business models that reduce environmental impacts and promote sustainability.

Sustainability Measures

Although sustainability is the key driver of innovation, there are no criteria/KPI or universal models that can characterize and evaluate the degree of sustainability of an organization. Sustainability is therefore measured through indirect quantitative parameters using the TBL approach consisting of economic, environmental, and social pillars. Also, each pillar affects a certain indicator, which was identified through the literature review presented earlier and supported by other authors. To create more classified criteria assessing how concepts such as Lean, and their integration affect sustainability, several sustainability indicators were identified as the most important, grouped, and illustrated (Table 2) a checklist.

Table 2. Sustainability indicators for three dimensions.

Economic	Environmental	Social
Profit Turnover Market Share Process Performance Operational Costs Production Cost	Renewal Energy production Product durability Development of new green technologies Industrial Waste Non-renewal energy consumption	Working conditions Workplace safety Decision-making liability (Autonomy, Worker engagement/ Satisfaction)

Environmental regulation and technological innovation

In the delicate balance between safeguarding the environment and promoting economic growth, what measures can governments take to steer enterprises towards sustainable development? This represents the “Hamlet” level of economic and social discourse regarding the interplay between environmental

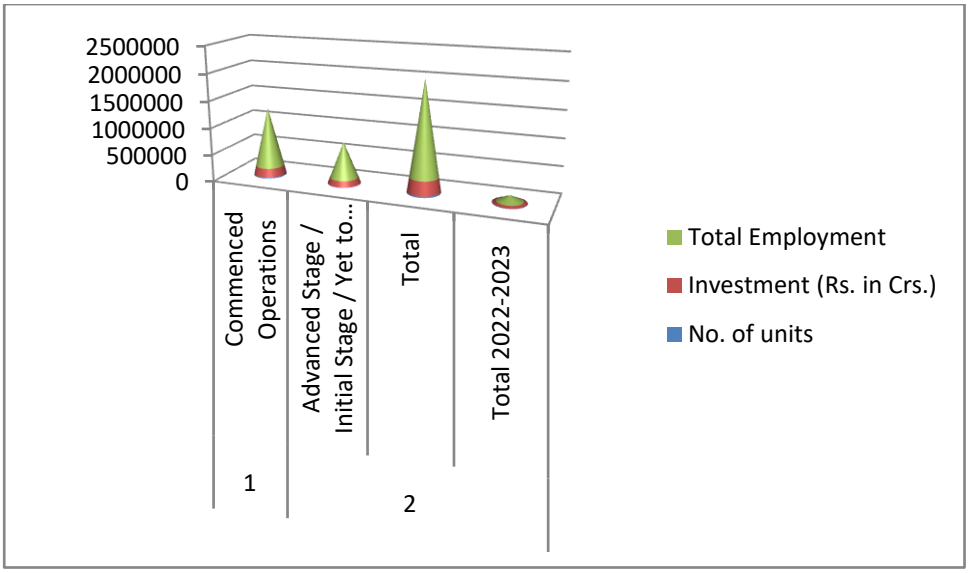
regulation and technological innovation, a question of economics that has been subject to constant debate since the 1820s up until the present times. There exist two overarching schools of thought regarding environmental regulation and technological innovation. The first, referred to as the restrictive hypothesis, is rooted in neoclassical economics and posits that such regulations impose a heavy burden on enterprises while impeding their progress. Argue that moderate environmental regulations can facilitate the expansion of a country's trade (the strong Porter hypothesis). Nevertheless, divergent opinions exist among scholars regarding the correlation between environmental regulation and technological innovation. Langpap & Shimshack contend that the implementation of environmental regulations escalates firms' expenses, particularly in industries with high ecological costs, which amplifies R&D expenditures and exerts an adverse influence on technological innovation. Xia et al. propose that the relationship between the intensity of environmental regulation and enterprise resilience follows an inverted U-shaped curve. Lin & Chen find a non-linear relationship between environmental regulation and technological innovation. Generally, the prevailing view supports Porter's hypothesis that under environmental regulation stimulation, enterprises will concentrate on differentiated competitive strategies, overcome environmental barriers through technological innovation, disseminate green product concepts, guide green consumption concepts and stimulate demand for green markets. The current debate centres on what type of environmental regulation can better promote technological innovation and whether the existence of such regulations can help companies break into international markets and develop new tracks for international competition SMEs,

SMEs, INNOVATIONAND RESEARCH ISSUES

The Small and medium enterprises (SMEs) in India provide employment to an estimated 31.2 million persons in the rural and urban areas of the country (Economic survey, 2010). During 2003-2007, the SME sector has registered continuous growth in the number of enterprises, production, employment and exports. Government of India earmarked a special role for small and medium scale industries in an Indian economy. Since 1951, a number of measures were taken to protect and promote small and medium enterprises. Protection and promotion of small and medium enterprises in India is a part of socio-economic policies of government which emphasizes judicious use of foreign exchange for import of capital goods and inputs; labour intensive mode of production; employment generation; non-concentration of diffusion of economic power in the hands of few (as in the case of large enterprises); discouraging monopolistic practices of production and marketing; and finally effective contribution to foreign exchange earning of the nation with low import-intensive operations. It is also coupled with the policy of de-concentration of industrial activities in few geographical centers. It is observed that by and large, SMEs in India are characterized with the following features: high contribution to domestic production; significant export earnings; low investment requirements; operational flexibility; location wise mobility; capacities to develop appropriate indigenous technology; import substitution; contribution towards defense production; technology-oriented industries; competitiveness in domestic and export markets. At the same time it is found that small and medium enterprises have number of limitations which come in their way to survive and grow, namely – low capital base; concentration of all functions in the hand of one/two persons; inadequate exposure to international environment; inability to face impact of WTO regime; inadequate contribution towards R&D; lack of professionalism etc. There is a need to explore the determinants of innovation in case of small and medium enterprisesin India. To be more specific, there are several research issues which need to be examined:

Table 3: Implementation stages of approved projects

S.No	Progress	No. of units	Investment (Rs. in Crs.)	Total Employment
1	Commenced Operations	18,423	1,54,966.30	10,99,398
2	Advanced Stage / Initial Stage / Yet to start construction	4,322	1,05,093.80	6,55,259
	Total	22,745	2,60,060.10	17,54,657
	Total 2022-2023	3,191	26,791.42	1,02,099



Overview of Sugar Industry

Department of Sugar has been working for self sustenance in Sugar & Ethanol production to achieve the objectives of New Biofuel policy and meet the Ethanol Blending Petrol targets. In this regard, the Department has taken steps for improving Production of Sugarcane, Sugar, Biofuel, etc., by diversification of sugar industry for promoting new distilleries and expanding existing distilleries under the new policy of Government thereby strengthening the sugar industry and stabilising the farm income of rural community and sustenance of sugarcane cultivation in Telangana. It is a fact that the Sugar industry is the only source for driving different ancillary industries such as Confectionary, Beverages, Food processing and to some extent transport, farm machinery etc.

The government of India has set a target of 43 Crs. Ltrs of Ethanol to be supplied by Telangana State towards Ethanol Blending Petrol Program so as to reach 20% blending by 2025.

The Sugar industry is providing annual employment of not less than 30,000 by direct & indirect in Sugar, Power & Ethanol production and contributing revenue to the exchequers through GST on Sugar, Ethanol, Molasses and other by-products besides taxes on raw materials used in the industry.

Table 4

S. No	Name of the Sugar Factory	Year of Establishment	Capacity Crushing Per Day (MT.s) (TCD)	Optimum Cane Required for 130 Days Season (Lakh MTs)	Distillery Installed Capacity (KLPD)	Cogen Installed Capacity (MW)
A	COOPERATIVE UNITS					
1	Nizamabad Coop sugars, Nizamabad	1964-1965	1250	1.63	0.0	0.00
B	GOVERNMENT JOINT VENTURE UNITS					
2	NDSL-Bodhan	1951-1952	3500	4.55	31.5	20.00
3	NDSL-Medak	1987-1988	2500	3.25	30.0	0.00
4	NDSL-Metpally	1980-1981	2500	3.25	0.0	0.00
C	PRIVATE UNITS					
5	Ganpati Sugars Sangareddy	1996-1997	5000	6.50	30.0	15.00
6	Trident Sugars Zaheerabad	1972-1973	3500	4.56	0.0	0.00
7	Gayatri Sugars Kamareddy	1997-1998	3500	4.55	45.0	6.00
8	Gayatri Sugars, Maagi	2006-2007	3500	4.55	0.0	16.25
9	Kakatiya Sugars Kallur	1991-1992	3200	4.16	0.0	16.70

10	Madhucon Sugars Rajeswara Puram	1983-1984	3500	4.55	64.0	24.20
11	Krishnaveni Sugars Kothakota	2010-2011	3500	4.55	120.0	28.20
Sector Total (Working Sugar mills)			25700	33.41	259.0	106.35
Grand Total (Including defunct mills)			35450	46.09	320.5	126.35

Performance - Sugar

Statement Showing The Cane Area , Cane Growers, Cane Crushed, Sugar Made, Recovery & FRP Paid To Farmers For 2022-23 Crushing Season In Telangana State

Table 5

No Of Sugar Mills In Operation	Crushing Capacity of working mills (TCD)	Cane Area (In Ha)	No of Farmers	Cane Crushed (Lakh MTs.)	Sugar Bagged (Lakh MTs.)	Recovery	FRP paid (Rs. Cr)	Total Price paid with additional price (Rs. Cr)
7	25700	32761	23484	24.63	2.61	10.62	805	813

Performance - Ethanol & Co-Gen Power

Statement Showing Ethanol Produced & Supplied To OMCs, Co-Gen Power Produced & Supplied To Power Grid For 2021-22 Crushing Season In Telangana State as on 12-04-2022

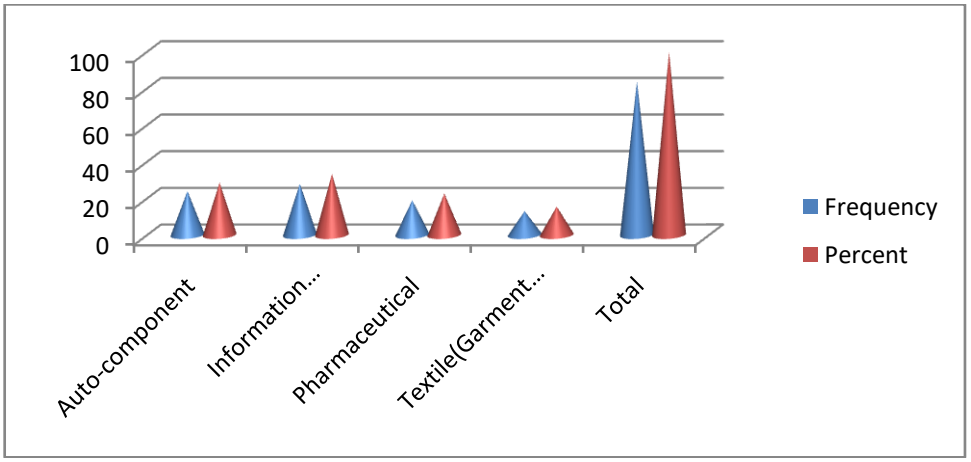
Table 6

Total No of Mills In Operation	Distillery Installed capacity (KLPD)	Ethanol produced (Kilo Bulk Litres)	Ethanol supplied to OMCs (Kilo Bulk Litres)	Co-Gen installed capacity (MW)	Co-Gen produced (MU)	Surplus power supplied to Grid (MU)
7	259.00	42558	18535	126.35	195.85	121.19

Sample Description

Table 7. Age Wise Distribution

Age class (years)	Frequency	Percent
0-10	27	32.15
11-20	37	44.05
21-30	14	16.66
31 and above	6	7.14
Total	84	100.00



Age-wise, the majority of the enterprises fall in the category of 11-20 years. Around 44% of the enterprises are in this category. Around 32% of the enterprises are young with age less than 10 years. The enterprises above the age-group of 20 years are around 24%.(see table 4-1).

Table 8. Size Wise Distribution

Type	Frequency	Percent
Small	33	39.3
Medium	51	60.7
Total	84	100.00

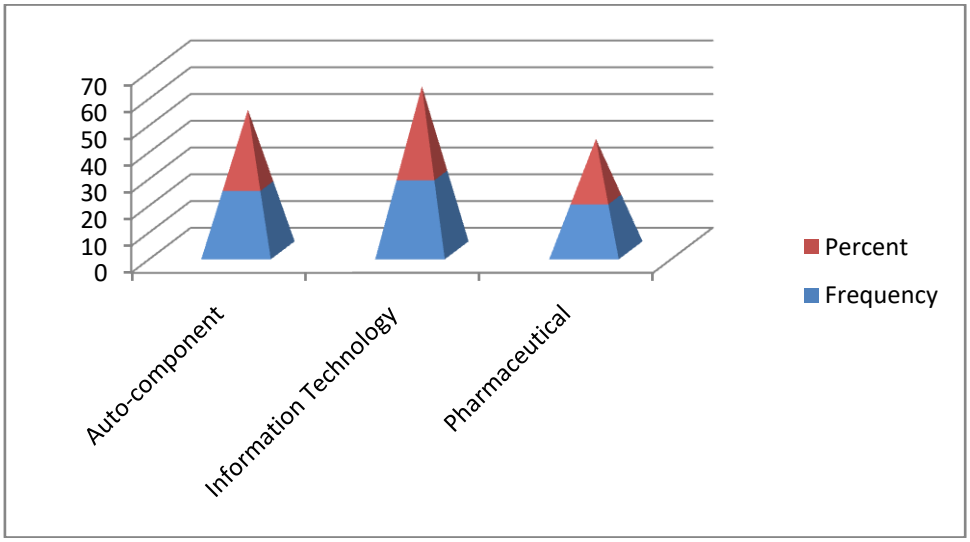
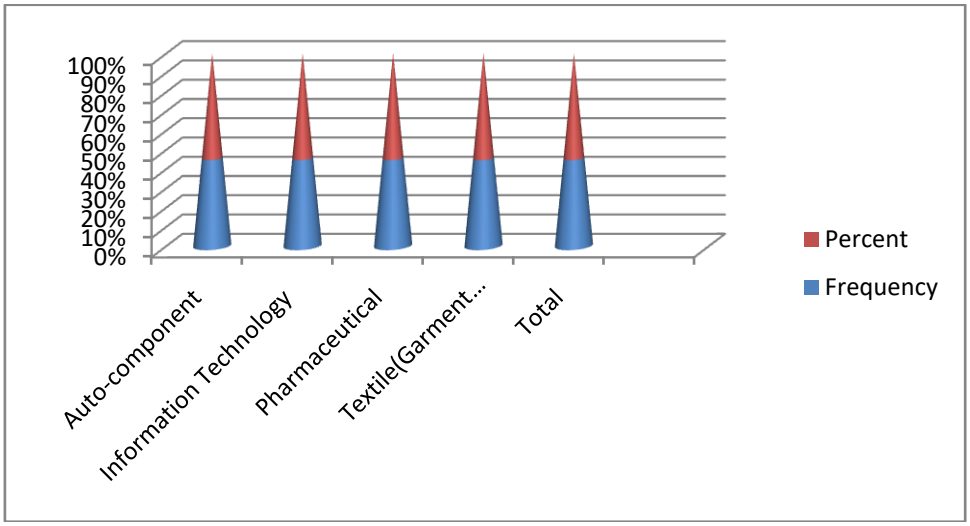


Table 8 shows that around 60 % of the enterprises are medium-size and approximately 40% are small-size enterprises.

Table 9. Location Wise Distribution

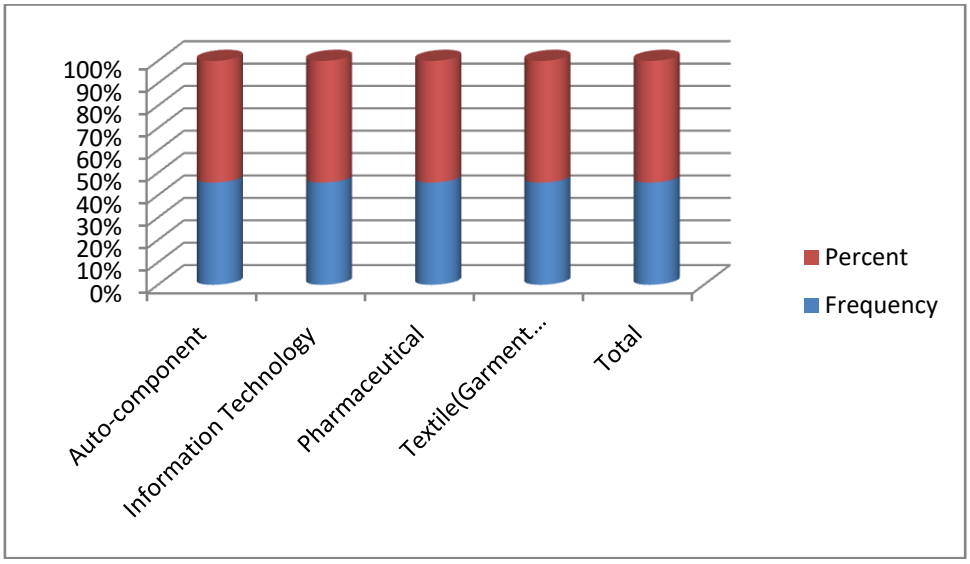
Location	Frequency	Percent
New Delhi	31	36.9
Gurgaon	9	10.6
Noida	13	15.5
Faridabad	5	6.0
Ghaziabad	26	31.0
Total	84	100.00



Location wise, around 37% of the enterprises are from New Delhi, 31% from Ghaziabad, 15.5% from Noida, 10.6% from Gurgaon and 6% from Faridabad. (see table 9).

Table 10. Total Employee Strength Wise Distribution

Employee strength class	Frequency	Percent
0-20	18	21.49
21-50	38	45.24
51-100	23	27.38
100 and above	5	5.89
Total	84	100.00



Employee strength-wise, around 45% of the enterprises are in the employee strength class 21-50, followed by 27% in the class 51-100, 21.49% in the 0- 20 class and 5.89% in the 100- above class. (see table 10).

Sector	Frequency	Percent
Auto-component	24	28.57
Information Technology	28	33.33
Pharmaceutical	19	22.61
Textile(Garment Manufacturing)	13	15.49
Total	84	100.00

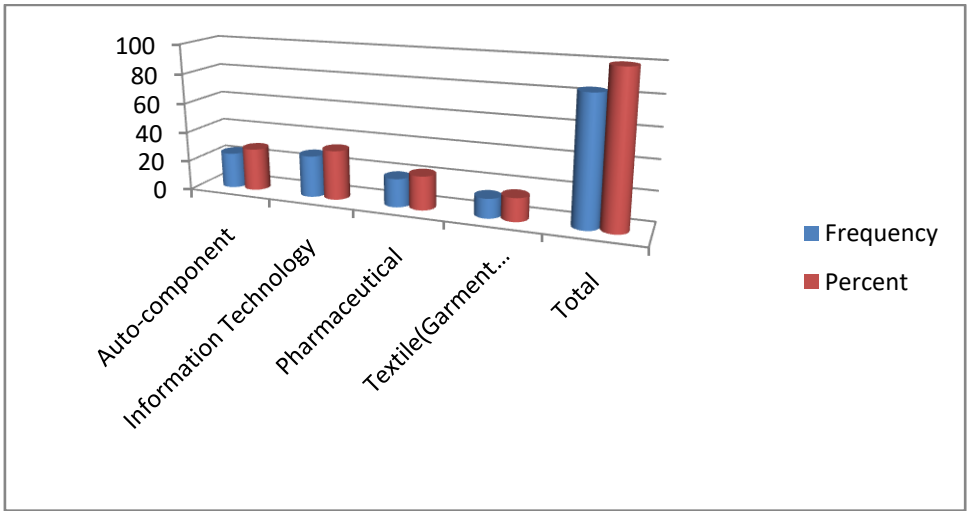
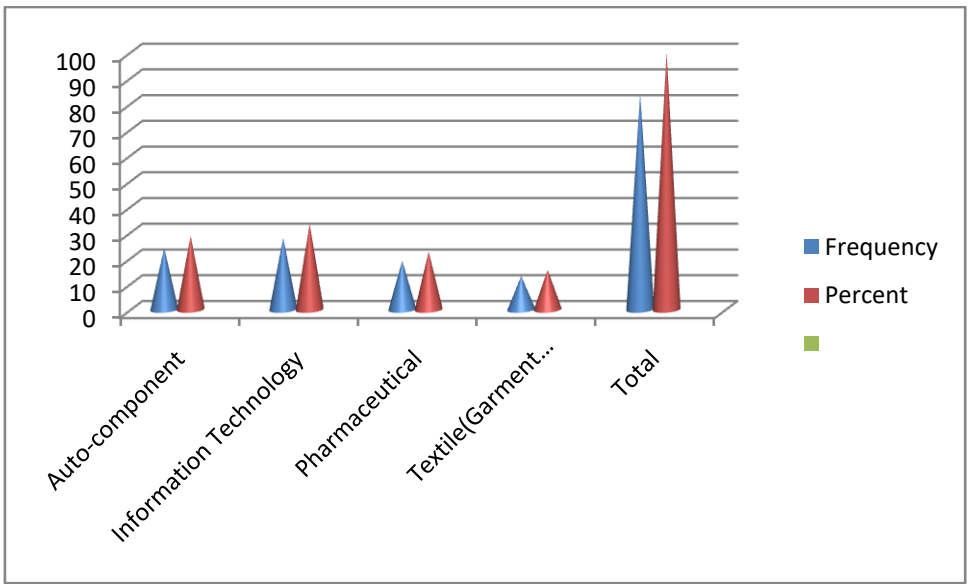


Table 10.1 shows that around 33.3 % of the small and medium enterprises belong to information technology (I.T.) sector, followed by 28% in the auto- component, 22% in pharmaceutical and 15% in the textile (garment manufacturing).

Table 11. Sector and Size Distribution

Sector	Small	Medium	Total
Auto-Component	14 (56)	11 (44)	25
I.T.	7 (26)	20 (74)	27
Pharmaceutical	6 (32)	13 (68)	19
Textile(Garment Manufacturing)	6 (46)	7 (54)	13
Total	33	51	84

Figures in ( ) indicate percentage.



The table 11 exhibits that 56 % of the enterprises are small-size enterprises and 44% of the enterprises are medium-size in auto-component sector, around one-fourth enterprises are small-size and approximately three-fourth enterprises are medium-size in I.T. sector, around one-third enterprises are small-size and 68% are medium-size in pharmaceutical sector, 46% of the enterprises are small-size and 54% of the enterprises are medium-sized enterprises in textile (GM) sector.

Findings

Small and medium enterprises are found to differ from each other in their capacity to manage innovation. They face similar barriers, i.e. shortage of funds, technical, shortage of skilled manpower etc. However, it is found that medium enterprises are better equipped to manage innovation because they are more experienced and resourceful. Labour-intensive sectors like auto-component and textile (GM) are more into process innovations. The product and process innovations resulted in lower cost, better efficiency and more benefits to the customers and made them more competitive. Age, representing experience gained over time, size is also found to be an important factor for small and medium enterprises. But in case of knowledge intensive sector, age has not appeared that significant as the young I.T. and pharmaceutical enterprises are found to be innovative.

CONCLUSION

Innovation is no longer driven by some individuals alone rather there are many occasions when it is market driven. Innovation varies not only among different sectors but also within the same sector. Innovation starts up from a basic desire to excel at one's work. It is an inherent urge to do something different to stand apart in crowd. It has direct relation with the need of the customer and dynamic market factors. Innovation includes all those activities which improve the production process (process innovation) and can also lead to a new product or change the quality of a product in terms oftherapeutic value (product innovation).Different researchers have defined innovation in different ways. Some have considered innovation as a product development or process design. Others take it as a management of

change in business or the process of making new products. Small and medium enterprises need to be innovative to sustain, survive and grow in competitive environment.

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